Active@ UNDELETE User Guide

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Active@ UNDELETE overview

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

`Active @ UNDELETE` is a software application designed to help you restore your lost data from deleted files, folders or even partitions.

Main Features short list

- Recover deleted files and folders.
- Detect deleted partitions and restore them or recover data from them.
- Create a **Disk Image** for safe data restoration.
- Perform an **Advanced Scan** and organize the result using **Scan Result view**.
- Restore data from damaged RAID-system drives.
- Work and recover data form dynamic RAID.
- Manage existing partitions or create new once using **Partition Manager** tool.
- Edit disk content with the advanced **Disk Editor** tool.
- Preview files before restoring.
- Supports HDD's larger then 2TB.

List of supported File Systems

- NTFS
- NTFS + EFS
- FAT
- FAT32
- exFAT
- Mac OS HFS+
- Linux Ext2/Ext3/Ext4
- Unix UFS
- BtrFS

General system requirements

- Windows 10, Windows 8, Windows 7, Windows 2000, Windows 2003, Windows Server 2008, Windows XP, WinPE
- Administrators privileges required to install and run software
- Pentium processor or compatible
- 60 MB available on hard disk
- 2048 MB of RAM or more
- Internet Explorer 8 or later, Google Chrome, Mozilla Firefox 1.0 or later
- Mouse or other pointing device

Getting started with Active@ UNDELETE

Active@ UNDELETE is designed to explore and browse all data storage devices on your computer in different ways to find and recover lost data. All information in the application is organized in tabbed views that provide easy access to information for different purposes.

New to Active@ UNDELETE?

To familiarize you with the *Active@ UNDELETE* workspace, read the following topics in this guide:

- *Active@ UNDELETE views and windows* on page 8
- *Recovery Explorer view* on page 8
- *Work with logical drive scan results* on page 16
- *Work with device scan results* on page 19
- *Search for deleted files and folders* on page 40
- *File filter toolbar control* on page 38
- *Application log* on page 126
- *Application preferences* on page 130

Ready to Use?

Start with essential application functionality - recovering files and restoring deleted partitions.

- *Recover files and folders from existing volume* on page 12
- *Recover files from deleted (damaged) partitions* on page 17
- *Recover files by their signatures* on page 22
- *Working with a corrupted RAID* on page 23
- *Restore partitions* on page 27
- *Using virtual storages* on page 59
- *Working with disk images* on page 54

Step-by-step guided wizards

Use guided tools for main tasks

- *Recover deleted files wizard* on page 66
- *Recover files detected by their signatures wizard* on page 68
- *Recover files from a formatted partition wizard* on page 72
- *Recover files from a deleted partitions wizard* on page 74
- *Recover files from a physical disk wizard* on page 76
- *Restore a deleted partition wizard* on page 81
- *Create a new partition wizard* on page 82
- *Create a disk image wizard* on page 76
- *Open a disk image wizard* on page 78
- *Verify a disk image wizard* on page 79
- *Create a virtual RAID wizard* on page 83

Advanced Tools

Move forward for advance using of `Active@ UNDELETE`:

- *Partition Manager* on page 107
- *Disk Editor*

- *File Organizer* on page 114
- *Forensic Report* on page 122

Active@ UNDELETE views and windows

Brief description of main application views and tools

All information in the application is organized in tabbed views. Four of the main views are:

Recovery Explorer view **on page 8**

The main (default) view of Active@ UNDELETE. In this view you can see all available Data Storage Devices and Logical Drives, Assembled RAIDs and opened Disk Images.

Work with logical drive scan results **on page 16**

The Drive Scan Result View displays all files detected after a logical drive scan.

Work with device scan results **on page 19**

Shows scan results made in context of Data Storage Device.

Search results view **on page 42**

This view is used to display search results after the search in corresponded context.

Application log **on page 126**

This log screen monitors each action taken by the application and displays messages, notifications and other service information.

Welcome view **on page 10**

Summary view with main tools, wizards and recent activity shortcuts.

File Organizer view **on page 116**

Utility view used to collect detected files from different sources, organize in file groups (folder) and recover them all at once.

To browse through each of these views, click on each tab in turn. You may also open a view from the **View** menu.

To close the current view at any time, press **CTRL+F4**. To open any closed view, select it from the **View** menu.

The status bar, at the bottom of the workspace shows the current status of the application or status of the activity in progress. When Active@ UNDELETE is idle and ready to perform an operation, the status displays "*Ready*".

To toggle the status bar click **View** > **Status Bar**.

Note: When you run Active@ UNDELETE, the application gathers information about disks and partitions available to the system. During this preliminary operation, the status bar displays "Initializing..." and application prevents most other operations from starting. **Application Log View** shows detailed information about the initialization stage.

To modify the information displayed in columns in a table list, right-click any column header and select or clear columns from context menu.

Recovery Explorer view

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

The main view in Active@ UNDELETE is **Recovery Explorer** view. This is the default view that you see after the application starts. It displays the hierarchical structure of all devices and drives, Virtual RAIDs or virtual devices and opened disk images. Scan results also appear here if you scan a device. To collapse or expand an item in this tree, click the arrow sign next to the item name.

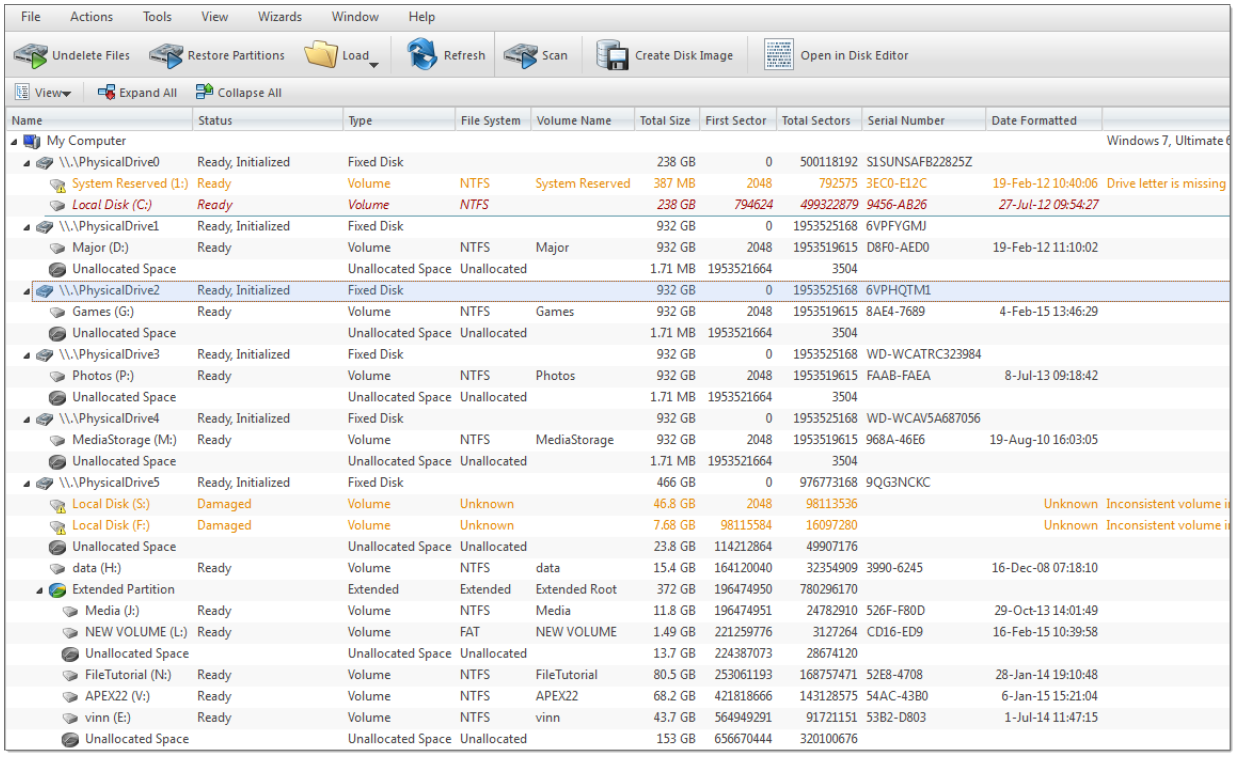


Figure 1: Recovery Explorer example

Recovery Explorer shows its content in several modes, that can be switched by view's toolbar drop-down menu button **View**.

Expert Device View (default)

At this mode, all available *data storage devices* with *logical drives* are present.

Local Drive View

At this mode, only accessible *logical drives* are present.

Partition View

Use this mode to show hierarchy of data storage devices partitioning (including *extended partitions* on MBR devices).

Enhanced View

At this mode, all available *Data Storage Devices* with hierarchy of *partitions* and *logical drives* are present; Use this mode for advanced features, such as Advanced Device Scan or Virtual Partition Management.

Show system drive

Hides or shows system drive for safety reason.

Show Local Network

Hides or shows shared network data storage resources.

To perform an action on any item (data storage device, logical drive etc.) select this and choose a command from:

- Toolbar at the top of the view;
- Menu **Actions**;
- or from the right-click context menu.

The **Properties Panel** displays default properties for each selected item. Updates to these properties appear dynamically along with commands and activities performed in the workspace. To toggle the Properties Pane click **View** > **Properties** pane. Read *Property views* on page 128 for more info.

Welcome view

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

This view appears when application starts and contains shortcut buttons for main tools, wizards and recent activity shortcuts divided in groups for easy access to `Active@ UNDELETE` features at application start.

Active @ UNDELETE
Version 10.1.27
Getting Started
File Recovery Wizards
Partition Management
Disk Image Management
Advanced Tools
Support
Version Info
Here are some commonly used actions when working with Active@ UNDELETE - Data Recovery Toolkit on a regular basis.
Recover deleted files
Use this wizard to recover accidentally deleted files or folders from your existing volumes.
Restore Deleted Partitions
Run Restore Partition Wizard.
Advanced Recovery Explorer
Start Recovery Explorer in Advanced Mode. Access Physical Devices to detect Deleted or Damaged partitions and undelete data.
Load Scan Results
Load previously saved Scan Results and open them in separate view.
Load Session
Load previously stored Application Session.
Enter Registration Key...
Enter registration key to activate application.
Recent Files
Scan Results
1. scan-9D-1212U.scan
Load Scan Results
Load Session
Open Disk Image...
Show this view on startup
Close

Figure 2: Default welcome view

Getting started

Contains most general starting points for file recovery and partition restoration.

Data Recovery Wizards

As it stated, on this page user can start file recovery wizards designed for different scenarios.

Partition Management

Allows to open **Partition Manager** or start wizards to create or format partitions.

Disk Image Management

Let to run wizards to create, open or verify disk images.

Advanced Tools

Advanced tools like open disks in **Disk Editor**, create *Virtual RAID* or decrypt files.

Support

Customer support and documentation.

Version Info

Contains version history and information about recent updates.

Recent files

Group of shortcut links to open recently used Disk Images, sessions or saved scan results.

Using Active@ UNDELETE

File recovery

Recover deleted files and folders **on page 12**

This is one of the essential features of `Active@ UNDLETE`. To recover accidentally deleted files, simply scan the drive where they were deleted, then browse scan results in familiar Windows-explorer like browser, search and filter results, select required files and recover them to safe location. You can preview scan results first to confirm that the detected files are exactly the once you need.

Scan for deleted partitions and files by their signatures **on page 18**

In some cases, you seek files from drives are not existing anymore - those partitions either deleted or overwritten by new one. It is still chance to recover some files in such condition! You have to located deleted partitions first and scan them as they are existing partitions and recover all detected files you need;

Recover files by their signatures **on page 22**

Active@ UNDELETE can find files by their unique format specification (signature) even if file can not be found in *Partition File Table*. For now, we can recognise various file formats:

- Microsoft Office Documents.
- Formatted Text files.
- Compressed Archives.
- Images and Camera Raw files.
- Music and Videos.
- QuickTime Multimedia files.

See *Supported file signatures* on page 51 for complete list of default file signatures.

User can create **custom**, user defined **File Signature Templates** to be used to detect files during low level disk scan by customized file signatures. See *Custom (user defined) file signature templates* on page 43 for details.

Virtual RAID Assembly **on page 63**

Disassembled *RAID* array can be virtually recreated by Active@ UNDELETE and some of the files located on these array can be recovered;

Partition restoration and management

Restore detected partition **on page 32**

You partition is gone? Accidentally deleted by user or by malicious software it is still chance it can be restored if not overwritten yet. Scan hard disk for deleted partition and use **Restore** command to get your partition back! We recommend you to restore your important data first;

Rollback partition changes **on page 111**

If all your manipulation with hard disk partitioning was made by using Active@ UNDELETE you can rollback (e.g. undo) all changes you have made in few clicks.

Partition Manager **on page 107**

By using small `Partition Manager` module in Active@ UNDELETE you can execute basic partition manipulation such as creation, formatting and delete. It can be useful during partition recovery operations;

Disk Images

Working with disk images **on page 54**

We advice to create *Disk Image* of a drive you work with before any actual recovery or partition restoration. It may prevent loosing data in accidental writing of cumulative hardware malfunction;

Advanced tools

Edit boot sectors **on page 112**

For advanced operations, you can manipulate partition table and boot sector attributes by using template dialogs;

Disk Editor **on page 86**

Advanced and integrated in Active@ UNDELETE environment disk editor - read and write data on low level.

File preview **on page 36**

To confirm that the file you have detected is exactly the file you seek, you can use *File Preview* feature before the actual recovery. It also helps to confirm file integrity first. Some restriction applies for *DEMO* version;

Recover deleted files and folders

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

In nutshell, file recovery requires scan of disk for deleted files first, review scan results and at the end - recover selected files to safe location. Scan can be applied on existing *logical drive* (or *volume*) in case when file was simply deleted for any reason. For more complex cases, when files were on deleted or damaged partition, a disk itself must be scanned for these deleted partition first, then in its turn scan detected partitions for files. And finally in the most difficult case, when files were lost on damaged or undetectable partition or even from unpartitioned disk at all, disk surface must be scanned for deleted files by using unique *files signatures*.

Some times your *RAID* controller dismount HDD array and you loosing access to your data. In this case, you can attach disks from array directly to the motherboard, use Active@UNDELETE to assemble virtual RAID from these disks and scan volumes on assembled array for files and recover them to safe location.

Some times files needs to be recovered from encrypted source to some intermediate data storage that not supports encryption (e.g. FAT32 formatted Flash card). For that you can use *Decrypt recovered files* on page 25 tool for a final recovery touch.

Recover files from existing volumes

Use this method for simplest file recovery. Recommended for most cases. Recover files by their signatures can be also applied for better results.

Recover files from deleted (damaged) partitions

If files where lost on deleted (damaged) partition

Recover files by their signatures

Use this technique to recover files from formatted partition or from unallocated (unpartitions) space on disk.

Recover files from broken RAID

Create Virtual RAID from disassembled disks to be able to scan them for deleted (unaccessable) files and folders,s

You can also restore entire partition, if its was deleted and detected in a good shape for recovery. However we are **strongly recommend** to recover files first to another location.

If you have a difficulties to determine the best scenarios, try *Active@ UNDELETE wizards overview* on page 66 - self guided step-by-step set of tools.

After you can see partitions on a device, the file recovery process consists of three stages.

Recover files and folders from existing volume

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

In most used cases, files needs to be recovered from existing disk volumes (logical drives) after accidental deletion or due to software malfunction. To recover detected files:

1. Scan volume

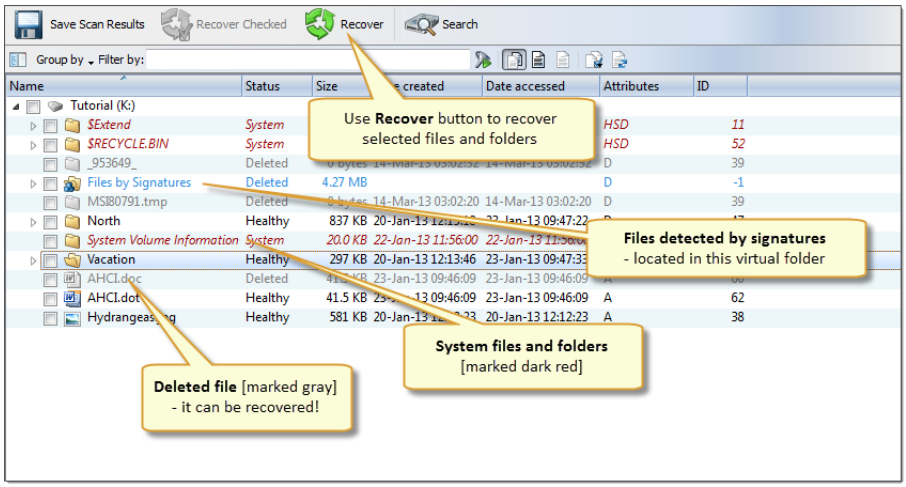
In order to recover deleted files from existing *logical drives* (*volumes*) the must be scanned first individually or several at once. For exact volume scan procedure read: *Scan a volume (logical drive) for deleted files* on page 13.

2. Analyze Scan Results

   A Logical Drive scan result appears in the *Work with logical drive scan results* on page 16 where results can be reviewed and files selected for recovery.

   File Grouping - detected files can be grouped for better analyzing by using the Group By drop-down menu in the toolbar. Detected files can be grouped by:

   - File Extensions;
   - By Associated Applications;
   - By Date (Created Date, Modified Date and Accessed or Deleted Date);



   Search and Filtering - detected files can be filtered by name, extension or deleted status by using the *File filter toolbar control* on page 38. For more narrow results *Search for deleted files and folders* on page 40 can be used.

3. Recover files

   You may recover damaged or deleted files and folders directly from any view that presents files, such us:

   - *Work with logical drive scan results* on page 16;
   - *Work with device scan results* on page 19
   - *Search results view* on page 42.

   Files also can be organized in groups before actual recovery by using *File Organizer* on page 114 tool.

   For more information about file recovery options read: *Recover detected files* on page 24 article.

4. Repeat [optional]

   Repeat steps 1-3 for different volumes using different scan attributes for better results if necessary.

Scan a volume (logical drive) for deleted files

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Scanning *logical drives* is a required step for recovering files and folders. During the scan all deleted (and existing) file and folders are detected. The results of a logical drive scan are displayed in a separate tabbed views: *Volume scan result view*.

Detected partitions, after disk scan, can be scanned in they turn in a same manner as live volumes (logical drives). Read *Scan for deleted partitions and files by their signatures* on page 18for details.

To scan a volume (logical drive):

1. Initiate volume scan

   From **Recovery explorer**:

   - Click **Undelete Files** button in view's toolbar or
   - Select logical drive and click **Scan** button in view's toolbar or
   - Use context menu **Scan** command

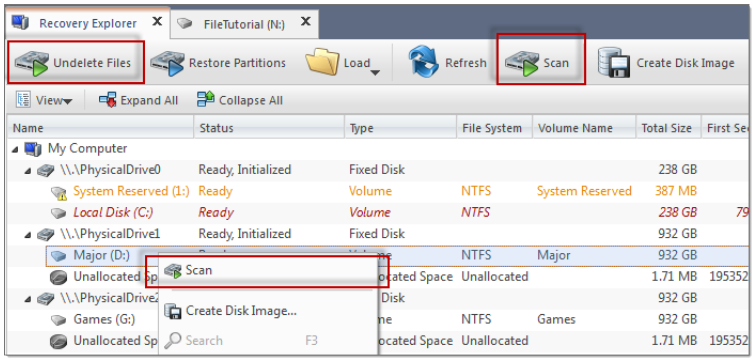


Figure 3: Initiate volume scan

Then **Scan Volumes** dialog should appear.

2. Specify scan attributes

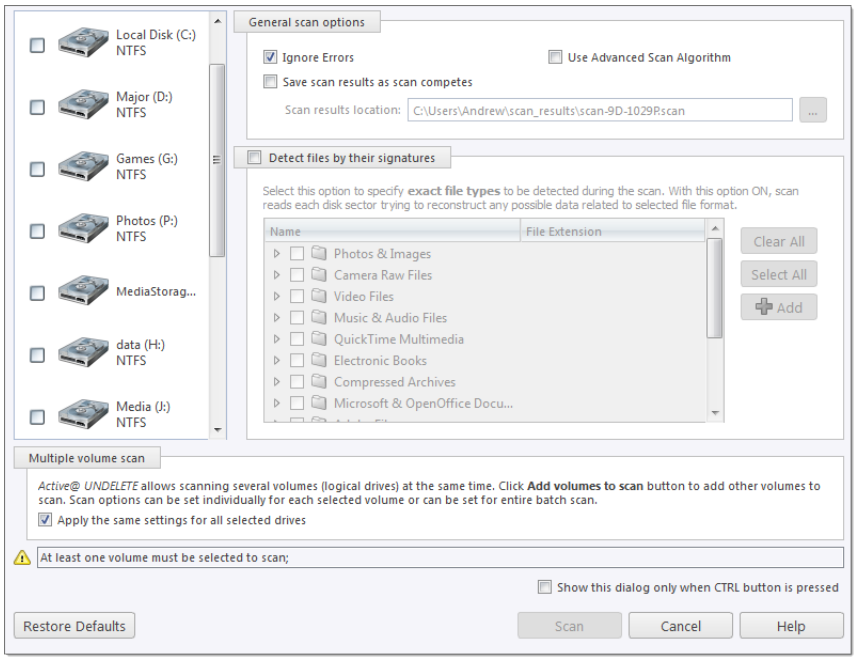

Local Disk (C:)
NTFS
Major (D:)
NTFS
Games (G:)
NTFS
Photos (P:)
NTFS
MediaStorag...
data (H:)
NTFS
Media (J:)
NTFS
General scan options
Ignore Errors
Use Advanced Scan Algorithm
Save scan results as scan competes
Scan results location:
C:\Users\Andrew\scan_results\scan-9D-1029P.scan
Detect files by their signatures
Select this option to specify exact file types to be detected during the scan. With this option ON, scan reads each disk sector trying to reconstruct any possible data related to selected file format.
Name
File Extension
Photos & Images
Camera Raw Files
Video Files
Music & Audio Files
QuickTime Multimedia
Electronic Books
Compressed Archives
Microsoft & OpenOffice Docu...
Clear All
Select All
Add
Multiple volume scan
Active@ UNDELETE allows scanning several volumes (logical drives) at the same time. Click Add volumes to scan button to add other volumes to scan. Scan options can be set individually for each selected volume or can be set for entire batch scan.
Apply the same settings for all selected drives
At least one volume must be selected to scan;
Show this dialog only when CTRL button is pressed
Restore Defaults
Scan
Cancel
Help

Figure 4: Scan Volume dialog example

Ignore errors

Ignore Read and Write errors during the scan process and continue without interruption.

Use advanced scan algorithm

Slower but more thorough scan algorithm. Required for *Recover files by their signatures* on page 22.

Save scan results

If this option is on, a path must be specified where scan results with a unique name will be saved for each scanned drive. Provide valid path if you have this option selected.

File signatures

Optionally select files to be detected by their signatures during the scan individually or by file group. For details read: *Recover files by their signatures* on page 22

Drives list

Additional drives can be selected to scan on the **Logical Drives** list to be scanned simultaneously. At least one logical drive (volume) must be selected.

Apply the same settings to all selected drives

All scan options above, can be selected for each drive individually or, when this check box is selected, to be the same for all selected logical drives.

Click **Scan** to initiate scan of selected logical drives (volumes).

3. Scan selected volumes

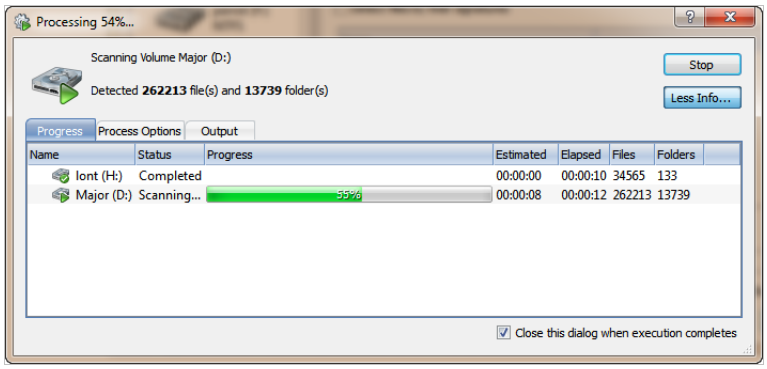


Figure 5: Scan in progress

During the scan:

- To display or hide scanning events and progress details toggle **More\Less Info** button at any time.
- To terminate the scan process, click **Stop** at any time. Results may be not accurate or complete.

After the scan completes you will see scan results in the *Volume scan result view*.

A Logical Drive scan result appears in the *Volume scan result view* where results can be reviewed and files selected for recovery.

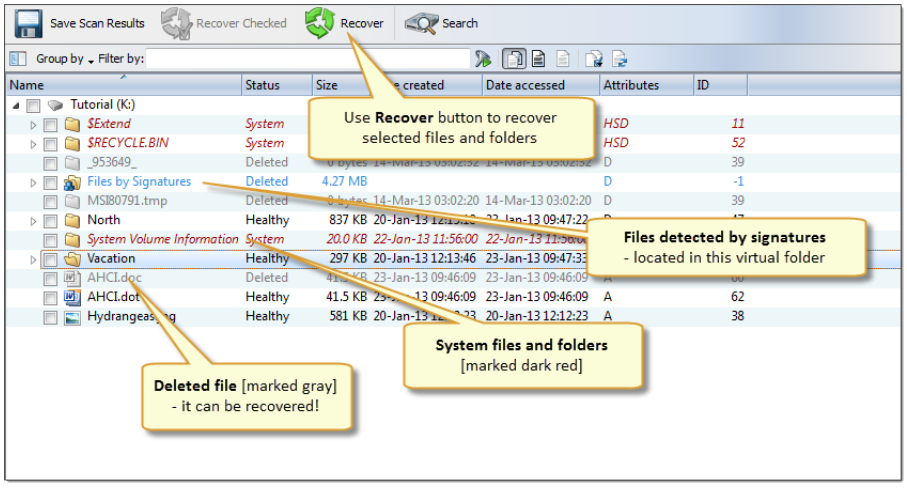


Figure 6: Volume scan result view

Note: We recommend you to save scan results to designated location for later use - you can use saved scan results to save time on repeated scanning of same volume.

Work with logical drive scan results

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

General description

Logical drive (volume) scan results view displays all files detected after a *logical drive scan*.

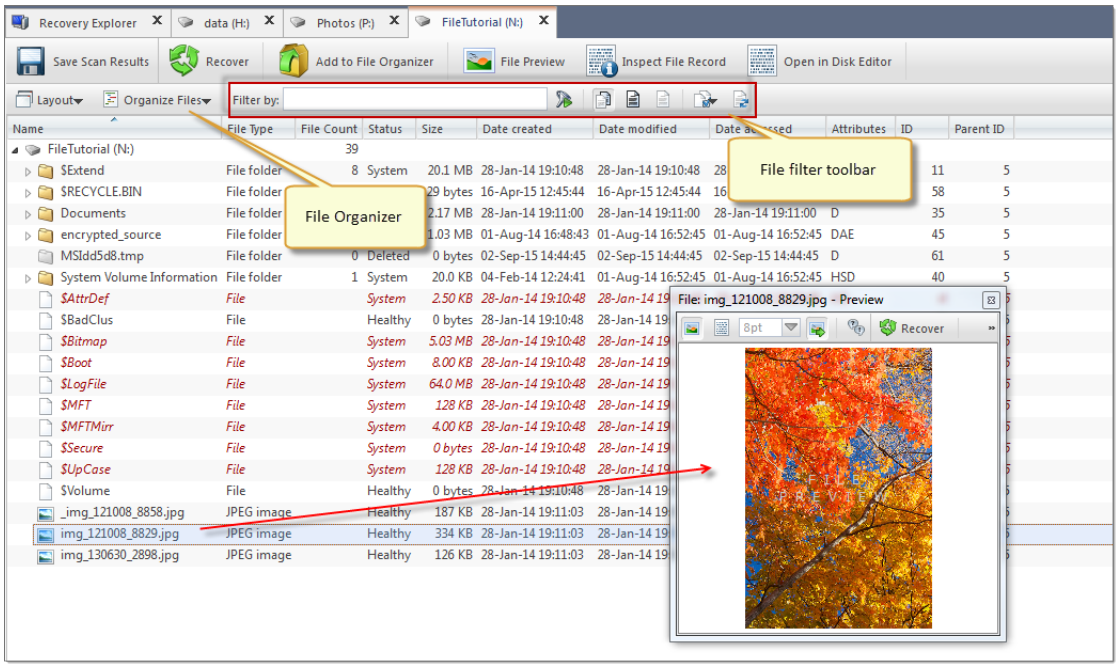


Figure 7: Volume scan result example

Drive Navigator

Show or hide left-sided navigation tree pane. To toggle this option use **Layout** > **Drive Navigator** menu from view's toolbar.

Organize files

Use feature to group detected files by:

- File extension;
- Associated application;
- Date (created, accessed and modified);
- and more.

Read *File Organizer* on page 114 article for detailed information about grouping sets and customization.

File filter toolbar

This control is used to filter files in scan result. Read *File filter toolbar control* on page 38 for usage information.

File preview

File preview is used to preview content and visually validate file before recovery *File preview* on page 36.

To make scan results easier to read, you may do the following:

- To sort the list by a column in ascending order, click the column header.
- To sort the list by the same column in descending order, click the column header a second time.
- To show a list that is reduced in size by a filter, select one of the preset options in the **File Filter toolbar**.

Search in folders

If volume contains too many files or location of required files is unknown use *Search for deleted files and folders* on page 40 feature - more advanced way to find files by their attributes and name patterns then simple filtering of contents of a scan. Search results will be shown in *separate tabbed view* and files can be recovered directly from search result as well.

To initiate search select context folder or drive (to search through content of all volume) and either:

- Select **Action** > **Search** command from main menu
- Click **Search** button in view's toolbar
- Use context menu **Search** command or
- Use **F3** keyboard shortcut for the same effect

Use File Organizer

File Organizer view on page 116 feature can be used to collect files from different sources (scans) in one hierarchical collection and recovered in one batch applied the same recovering attributes for all selected file, like naming convention or file attributes. To add file from scan result to `File Organizer`:

1. Select files in scan results using **CTRL** and **SHIFT** keyboard keys for multiple selection and
2. - Select **Action** > **Add to File Organizer** command from main menu
   - Click **Add to File Organizer** button in view's toolbar or
   - Use **Add to File Organizer** command from context menu

Repeat these commands if necessary for the same or for different file sources (scan results).

Use Disk Editor

Files in this view can be edited in advanced hexadecimal Disk Editor. To open file in Disk Editor:

- Click **Open in Disk Editor** button in view's toolbar or
- Use **Open in Disk Editor** command in context menu

To view file record click **Inspect File Record** button in toolbar or use

Tip: It is recommended to *save scan results* for later use.

When you have found all files you looking for - proceed to *Recover detected files* on page 24.

Recover files from deleted (damaged) partitions

If lost files were on deleted or damaged partition, then procedure of file recovery is slightly different then *Recover files and folders from existing volume* on page 12.

1. Scan disk (physical drive)

   Apply scan directly on physical drive (disk), ignoring its logical structure in order to detect deleted (damaged) partition. For exact scan procedure read: *Scan for deleted partitions and files by their signatures* on page 18 article.
2. Analyse scan results

   A disk scan result appears in the *Work with device scan results* on page 19 view where results can be reviewed and files selected for recovery.
3. Scan detected partitions

   Detected partition can must be scanned in a same manner as existing volumes. Follow recommendations in *Recover files and folders from existing volume* on page 12 article to continue.

   Note: If files was detected already by their signatures no further steps are necessary - use *Recover detected files* on page 24 procedure to recover detected files to the safe location.
4. Review results and recover detected files.

Review in scan results group of files detected by their signatures or detected partition scan results.

Repeat steps 1-3 using different scan attributes for better results if necessary.

Scan for deleted partitions and files by their signatures

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

A physical device is an installed hard disk, Flash card, external USB disk or any device that holds data. It can be scanned in order to detect deleted (damaged) partitions or files by their signatures at the same time.

Detected partition can be scanned as any other *logical drive* for files and folders. You can scan detected partition to verify partition content before *partition restoration* or to be able to *recover (copy) files* to safe location if partition was deleted or damaged.

To scan a physical device for deleted partitions or files:

1. Initiate disk scan

   From **Recovery explorer**:

   - Click **Restore partitions** button in view's toolbar or
   - Select a disk (physical device) item and click **Scan** button in view's toolbar or
   - Use **Scan** command from context menu
   - Double-click and disk (physical device) node

2. Specify scan attributes

   Define scan range and other scan attributes if necessary.

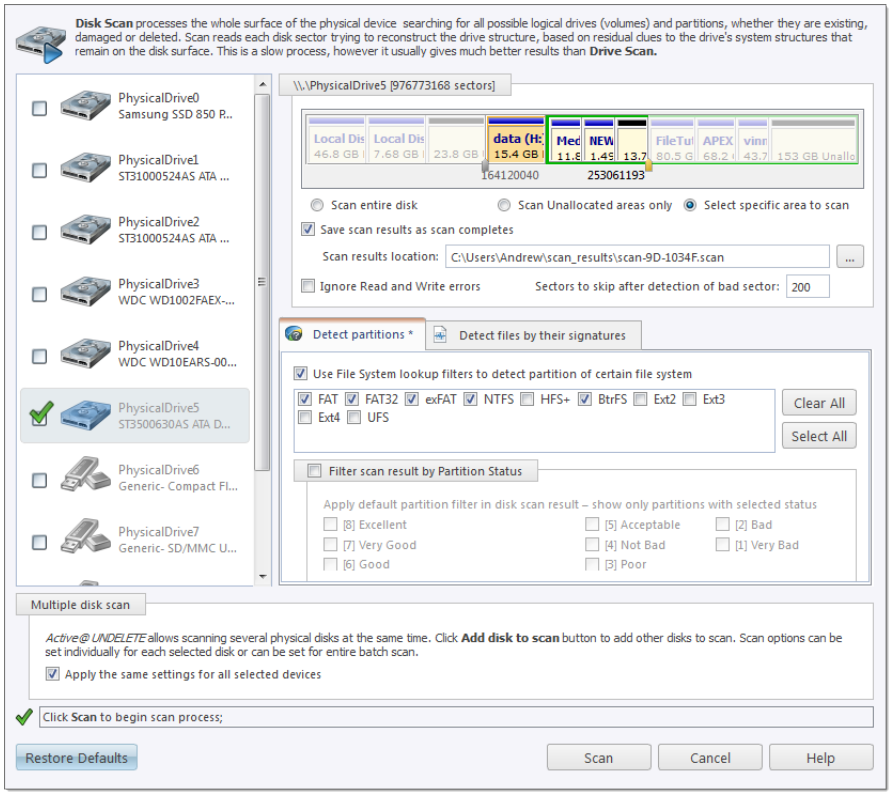

Disk Scan processes the whole surface of the physical device searching for all possible logical drives (volumes) and partitions, whether they are existing, damaged or deleted. Scan reads each disk sector trying to reconstruct the drive structure, based on residual clues to the drive's system structures that remain on the disk surface. This is a slow process, however it usually gives much better results than Drive Scan.
PhysicalDrive0 Samsung SSD 850 P...
PhysicalDrive1 ST31000524AS ATA ...
PhysicalDrive2 ST31000524AS ATA ...
PhysicalDrive3 WDC WD1002FAEX-...
PhysicalDrive4 WDC WD10EARS-00...
PhysicalDrive5 ST3500630AS ATA D...
PhysicalDrive6 Generic- Compact Fl...
PhysicalDrive7 Generic- SD/MMC U...
\\.\PhysicalDrive5 [976773168 sectors]
Local Dis 46.8 GB
Local Dis 7.68 GB
23.8 GB
data (H: 15.4 GB
11.8
1.45
13.7
FileTul 80.5 G
APEX 68.2
vinr 43.7
153 GB Unallo
164120040
253061193
Scan entire disk
Scan Unallocated areas only
Select specific area to scan
Save scan results as scan completes
Scan results location: C:\Users\Andrew\scan_results\scan-9D-1034F.scan
Ignore Read and Write errors
Sectors to skip after detection of bad sector: 200
Detect partitions *
Detect files by their signatures
Use File System lookup filters to detect partition of certain file system
FAT FAT32 exFAT NTFS HFS+ BtrFS Ext2 Ext3 Ext4 UFS
Clear All
Select All
Filter scan result by Partition Status
Apply default partition filter in disk scan result – show only partitions with selected status
[8] Excellent
[7] Very Good
[6] Good
[5] Acceptable
[4] Not Bad
[3] Poor
[2] Bad
[1] Very Bad
Multiple disk scan
Active@ UNDELETE allows scanning several physical disks at the same time. Click Add disk to scan button to add other disks to scan. Scan options can be set individually for each selected disk or can be set for entire batch scan.
Apply the same settings for all selected devices
Click Scan to begin scan process;
Restore Defaults
Scan
Cancel
Help

Figure 8: Disk Scan dialog

Scan area selector

Select scan area using predefined options: *entire disk*, *unallocated only* or *specific range* - use arrow markers to mark scan area;

Note: Scan area markers shown first and last sectors of scanning area. To enter exact start and end sectors to scan click on sector label and enter exact value in text field;

Save Scan results

Enter path, where scan results will be saved as soon as scan completed;

Ignore Errors

Ignore disk Read/Write Errors;

Sectors to skip

Amount of sectors to skip in case of read errors. Use this attribute to avoid scan prolonging on massive bad sectors arrays.

Detect partitions

Select desired **File System** of a partitions to be detected;

Detect files by their signatures

Select this option to specify exact file types to be detected during the scan. With this option, device scan reads each disk sector trying to reconstruct any possible data related to unique file format.

Important: Turn this option off when you only want to detect and restore partition - it will significantly save your scanning time.

Scan results filter

Define scan results refining filter by partition integrity status.

Multiple drive selection

Additional disks can be selected to scan on the **Physical disks** list to be scanned simultaneously. At least one disk must be selected.

Apply the same settings to all selected devices

All scan options above, can be selected for each drive individually or, when this check box is selected, to be the same for all selected logical drives.

Click **Scan** to initiate scan of selected disks.

3. Scan selected disks

During the scan:

- To display or hide scanning events and progress details toggle **More\Less Info** button at any time.
- To terminate the scan process, click **Stop** at any time. Results may be not accurate or complete.

After the scan completes you will see scan results in the *Work with device scan results* on page 19.

A Logical Drive scan result appears in the *Device scan result view* where results can be reviewed and files selected for recovery.

Note: We recommend you to save scan results to designated location for later use - you can use saved scan results to save time on repeated scanning of same volume.

Work with device scan results

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

General description

Physical device scan view is used to review scan results, that includes *partitions* and files detected by signature, after device scan made on data storage device.

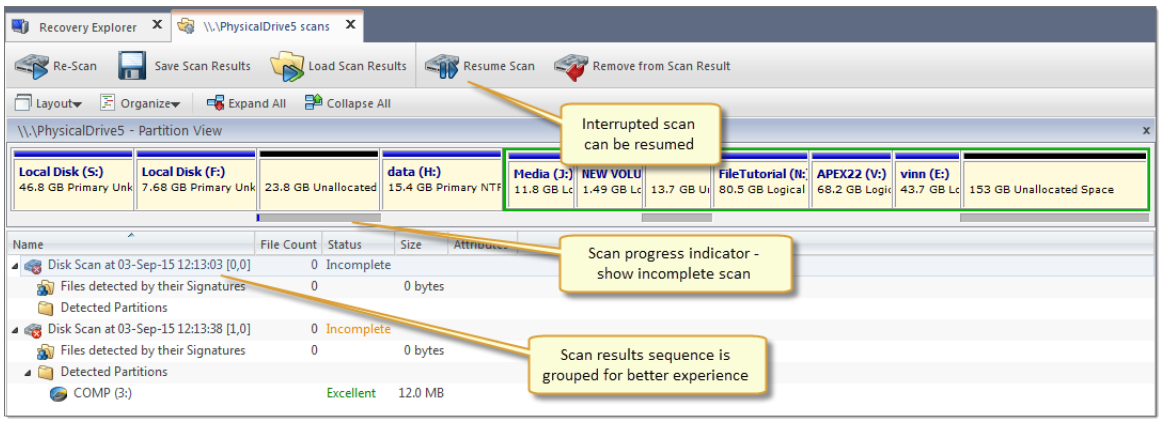


Figure 9: Interrupted Physical Device Scan

Device scan history

Show or hide device scan tree panel used for navigation of left side of a view. Use **Layout** > **Device scan history** menu commands from view's toolbar to toggle this option.

Organize files

Use feature to group detected files by:

- File extension;
- Associated application;
- Date (created, accessed and modified);
- and more.

Read *File Organizer* on page 114 article for detailed information about grouping sets and customization.

Expand All

Expand all scan result groups

Collapse All

Collapse all items to scan result groups

Tip: It is highly recommended to save scan results for later use: *Using scan results* on page 33

Re-scan

Context data storage device (disk) *can be rescanned* with different attributes and scan boundaries. All new results will appear in a same view under new scan result group for better results comparison and organization for recovery.

Save and load scan results

Scan results can be saved individual for later use. Read *Preserve scan results* on page 34 article for details.

Device Partition view control

In Device Scan view, scanned devices represented by **Device view control**. For each selected scan, Device View control shows scan progress indicator: blue stripe means scan is incomplete and solid green stripe - scan is complete for selected range. All interrupted (incomplete) scans can be resumed by clicking **Resume** button in view's toolbar or by command **Resume Scan** in item context menu.

If detected partition is selected, its relative position and scanned size is also displayed on Device View Control indicating is this partition is recoverable or not.

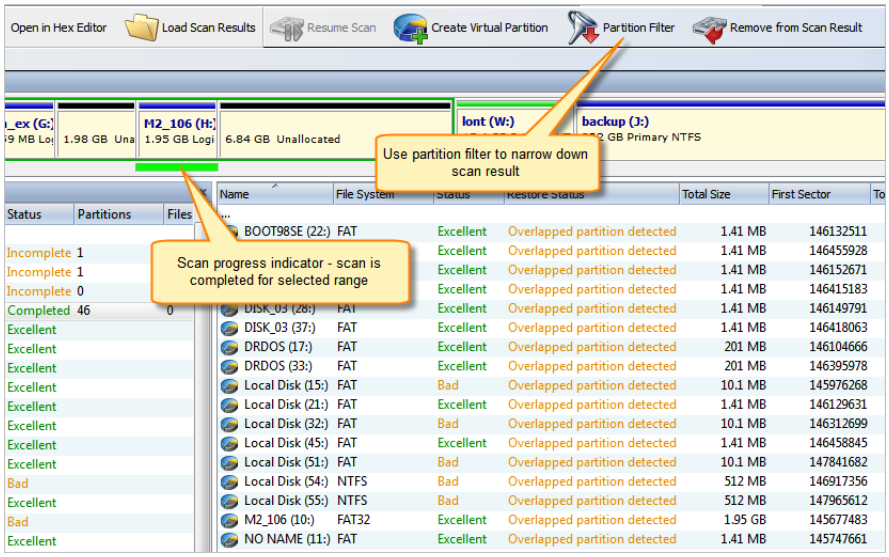


Figure 10: Complete Physical Device Scan

Working with detected partitions

Detected partitions displayed with their status to be recovered and overall partition integrity. When partition *Recover Status* is "Can be recovered" then this partition can be restored as part of disk partitioning. To restore detected partition select it in view and click **Restore** button in view's toolbar or use **Restore** command from item's context menu.

Read *Restore detected partition* on page 32 article for exact procedure.

If partition cannot be restored by any reason, data from this partition still can be recovered. To do so, partition must be scanned (as regular Logic Drive) and files needs to be selected individually and recovered to safe location.

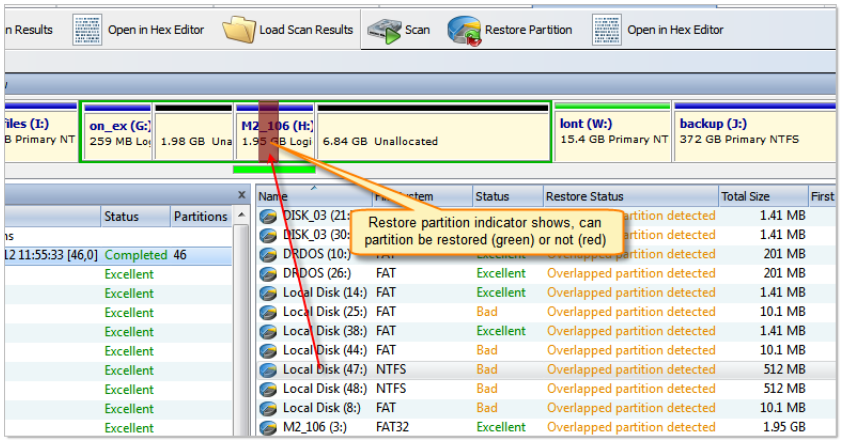


Figure 11: Detected partition indicator

For deeper analysis of detected partition you can also:

Scan

Scan detected partition to evaluate validity if its content.

Edit boot records

Edit partition attributes before restoring.

Open in Disk Editor

Open partition in Disk Editor - advanced hexadecimal build-in disk editor.

Working with files detected by signatures

Files detected by signatures are shown under related disk scan item and combined in groups by signature type (default). Original file names can not be recovered due to feature limitations, however they can generated in meaningful pattern by using file attribute meta tags in *File Organizer* on page 114 tool.

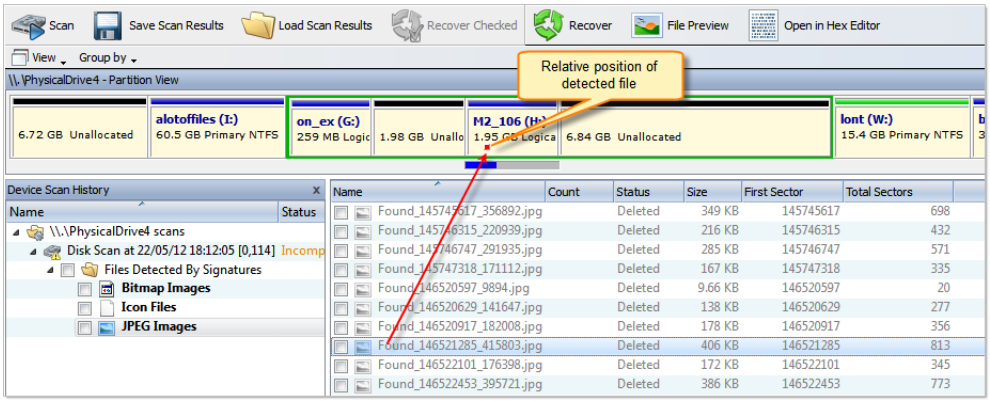


Figure 12: File Detected by signatures

Read *Recover detected files* on page 24 article for exact recovery steps.

Recover files by their signatures

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Files on hard drive can be detected by their unique file signatures. `Active@ UNDELETE` can detect these files (see *Supported file signatures* on page 51 for exact list of file types) during *Scan a volume (logical drive) for deleted files* on page 13 or *Scan for deleted partitions and files by their signatures* on page 18. In first case, scanning will be limited by volume boundaries when by scanning physical disk, you can specify custom boundaries of disk surface to scan.

Volume (logical drive) scan

During volume of scan you have to select file signatures on scan dialog and they will be detected (if any) among other deleted or live files on selected volume(s) only.

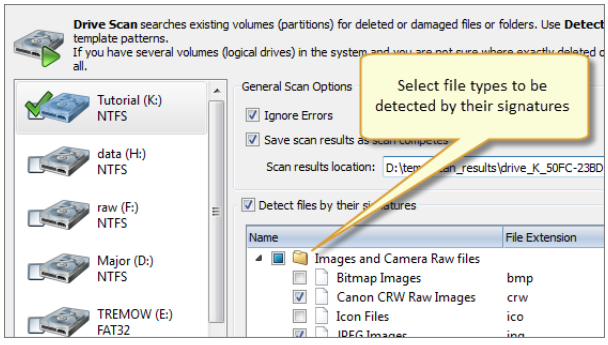


Figure 13: Scan volume dialog - add file signatures

Note: See *Scan a volume (logical drive) for deleted files* on page 13 for more information.

Physical disk scan

Files by signatures can be also detected during scan of disk surface not limited by volume boundaries.

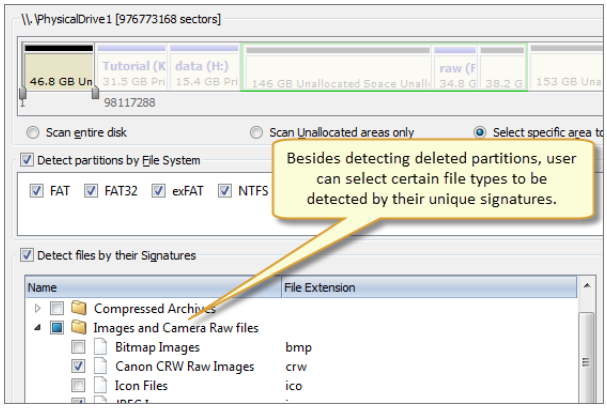
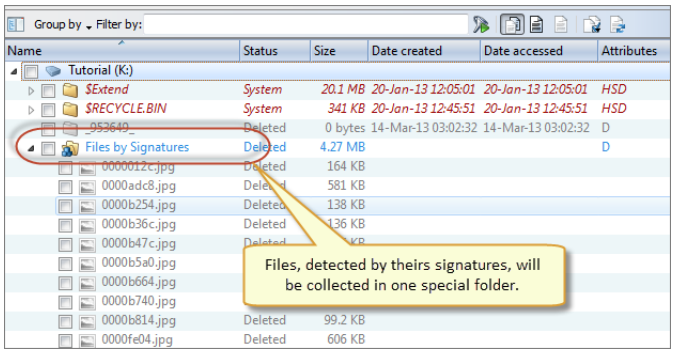


Figure 14: Scan disk dialog - add file signatures

Note: See *Scan for deleted partitions and files by their signatures* on page 18 for more information.

Evaluate scan results

Detected files (if any) are shown in scan result view grouped in special virtual folder named *Files by Signatures*. Due to particular qualities of this algorithm, it is impossible to recover original file names, date and other attributes. To evaluate integrity of some of the detected files you can use *File preview* on page 36 feature.



Note: Amount of selected files signatures directly impacts on total scan time.

Recover detected flies

Files, detected by their signatures can be recovered in a same manner as other detected files. The main differences only - file names. Due to nature of detection algorithm all names for that files generated during the scan and original names can not be discovered. You can use *File Organizer* on page 114 feature to assign meaningful names for these files using internal file attributes (meta tags) or simple renaming patterns.

Read *Recover detected files* on page 24 article for exact recovery procedure.

Working with a corrupted RAID

Active@ UNDELETE is an advanced data recovery toolset allows to reconstruct damaged or broken RAIDS.

If you have a corrupted *RAID* configuration and one or more drives in the array are damaged, you can combine the healthy drives together with the damaged drives in a *virtual disk array* (*Virtual RAID*). If the damaged drives are inaccessible, you can substitute a "dummy" drive as a replacement. `Active@ UNDELETE` simulates the RAID assembly and you can scan this virtual array as a logical device.

To get access to the files on damaged raid and recover them follow:

1. Create virtual RAID

Use *Virtual RAID Assembly* on page 63 procedure to create virtual array. You can create unlimited number of arrays with different attributes and disk combinations for better access.

2. Recover files from RAID assembly

   After Virtual RAID is created you can use one of the methods below to retrieve files from assembled RAID to safe location:

   - *Recover files and folders from existing volume* on page 12
   - *Recover files from deleted (damaged) partitions* on page 17
   - *Recover files by their signatures* on page 22

Recover detected files

You may recover damaged or deleted files and folders directly from the *Recovery Explorer view* on page 8, *Work with logical drive scan results* on page 16, *Work with device scan results* on page 19 and *Search for deleted files and folders* on page 40. Recovering deleted files and folders is one of the essential features of `Active@ UNDELETE`.

1. Select files in a view

   Select files in any view mentioned above using cursor selection (Use **Shift** or **Ctrl** keys for mutli-selection).

2. Open **File and Folder recovery** dialog

   After files are selected in a view, click **Recover** button in view's toolbar or use **Recover** command from context menu or use **Ctrl+R** shortcut.

3. Confirm recovery location and attributes

   By default **File recovery dialog** appears in simplified form - in most of the cases default recovery settings are sufficient for file recovery. However, to use advanced options click **More Recovery Options** button.

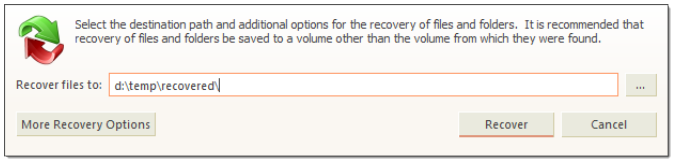

Select the destination path and additional options for the recovery of files and folders. It is recommended that recovery of files and folders be saved to a volume other than the volume from which they were found.
Recover files to:
d:\temp\recovered\
More Recovery Options
Recover
Cancel

Figure 15: File Recovery dialog - simplified

Enter destination path where file will be recovered and click **Recover** button.

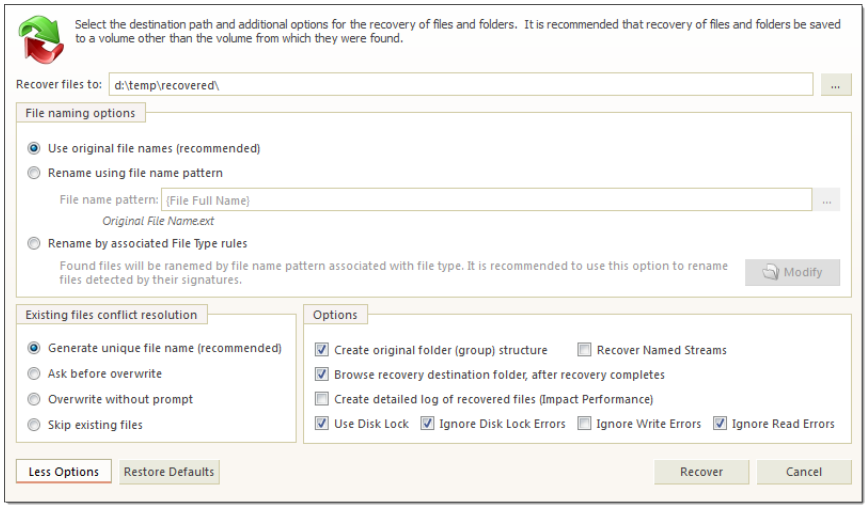

Select the destination path and additional options for the recovery of files and folders. It is recommended that recovery of files and folders be saved to a volume other than the volume from which they were found.
Recover files to:
d:\temp\recovered\
File naming options
Use original file names (recommended)
Rename using file name pattern
File name pattern:
(File Full Name)
Original File Name.ext
Rename by associated File Type rules
Found files will be ranemed by file name pattern associated with file type. It is recommended to use this option to rename files detected by their signatures.
Modify
Existing files conflict resolution
Generate unique file name (recommended)
Ask before overwrite
Overwrite without prompt
Skip existing files
Options
Create original folder (group) structure
Recover Named Streams
Browse recovery destination folder, after recovery completes
Create detailed log of recovered files (Impact Performance)
Use Disk Lock
Ignore Disk Lock Errors
Ignore Write Errors
Ignore Read Errors
Less Options
Restore Defaults
Recover
Cancel

Figure 16: File recovery dialog - extended

Use original file names

Names of detected files will be preserved only if no file with the same name already exists in the destination directory.

Rename files

All files will be renamed by their given specified file root name and added enumeration ID. File extensions remain intact.

Unique file name

If a file with the same name exists in the destination folder, a file with a unique name will be generated to avoid overwriting.

Ask before overwrite

If a file with the same name already exists in the destination folder, the application will ask the user for a specific action to take.

Overwrite without prompt

All files will be overwritten in the event if they already exist in the destination folder.

Skip existing files

If a file with the same name exists in the destination folder, recovery of a new file will be skipped.

Create Folder Structure

When this option is selected files will be recovered with their original folder structures e.g. original folder hierarchy as it was on the storage source. In case files were organized in groups (date, file extensions, or by an associated application) then such groupings will be created by the folder structure in the location where the files will be recovered to.

Recover Name Streams

With this option on, files will be recovered with their original name streams.

Browse destination folder

Opens the destination folder in the default OS file browser.

Detailed Log

With this option on, the log file contains more detailed information about recovered files.

Use Disk Lock

The source disk will be locked during the file recovery process. It will be unlocked as soon as the process is completed.

Ignore Disk Lock Errors

With this option on, the file recovery process will continue even if locking of the source device fails.

Ignore Write Errors

No error messages will appear and all write errors will be ignored during the recovery process.

Ignore Read Errors

No error messages will appear and all read errors will be ignored during the recovery process.

Click **Recover** button to begin file recovery.

4. Observe recovery process

   Observe recovery process and verify recovered files in destination folder. Repeat recovery process if necessary.

If files were recovered successfully they will appear in destination folder. Repeat steps 1-3 if necessary.

Decrypt recovered files

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

During the recovery of encrypted files to any destination that doesn't support encryption, `Active@ UNDELETE` creates temporary (*.EFS) files. These files can be decrypted later at any time by using the **File Decryption Tool**.

1. Open the Decrypt Files dialog
   - Use the command tools and select **Decrypt Files** from the main menu.
   - From the **Tools** tab in the command bar, choose the **Decrypt Files** command.
2. Add files to decrypt

   Add temporary recovered encrypted files (*.efs) or open the Decrypted Files log (*.txt) created during recovery by using the **Add** button.

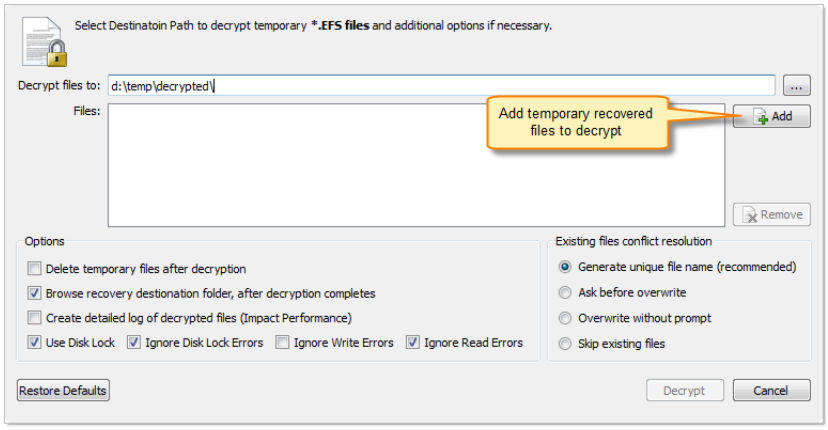


Figure 17: Decrypt files dialog box

Delete temporary files

All temporary recovered encrypted source files will be deleted after decryption.

Browse Destination

The folder where files will be decrypted will be opened by the default OS files browser.

Create Detailed Log

The log files will contain more detailed information about the forthcoming process.

Use Disk Lock

The source disk will be locked during the file recovery process. The disk will be unlocked as soon as the process is completed.

Ignore Disk Lock Errors

With this option on, the file recovery process will continue even if locking of the source device fails.

Ignore Write Errors

No error messages will appear and all write errors will be ignored during the recovery process.

Ignore Read Errors

No error messages will appear and all read errors will be ignored during the recovery process.

Generate unique file name

If a file with the same name exists in the destination folder, then a file with a unique name will be generated to avoid overwriting.

Ask before overwrite

If a file with a certain name already exists in the destination folder, the application will ask the user for a specific action to take.

Overwrite without prompt

All files will be overwritten even if they already exist in the destination folder.

Skip existing files

If a file with the same name already exists in the destination folder, recovery of that file will be skipped.

3. Decrypt selected files

   Set other options if necessary and then click the **Decrypt** button to complete the task.

When process completes decrypted files will appear in destination folder.

Restore partitions

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

If you cannot see partitions on your device, or if you know that partitions are missing, you may first scan a device to find partitions. Restoring a deleted or damaged partition can be done in three stages:

1. Scan disk

   Scan a physical device individually or several at once for a deleted or damaged partitions. Usually, only unallocated space needs to be scanned.

   For details about scanning read: *Scan for deleted partitions and files by their signatures* on page 18.
2. Evaluate scan results

   Review scan results and analyse detected partition integrity (restoration status) and validity. Use *partition filter* and preliminary partition scan to examine detected partitions before restoration.

   For details read: *Work with device scan results* on page 19
3. Restore partition

   Restore deleted partition at previous location.

   For detailed reference read: *Restore detected partition* on page 32

Scan for deleted partitions and files by their signatures

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A physical device is an installed hard disk, Flash card, external USB disk or any device that holds data. It can be scanned in order to detect deleted (damaged) partitions or files by their signatures at the same time.

Detected partition can be scanned as any other *logical drive* for files and folders. You can scan detected partition to verify partition content before *partition restoration* or to be able to *recover (copy) files* to safe location if partition was deleted or damaged.

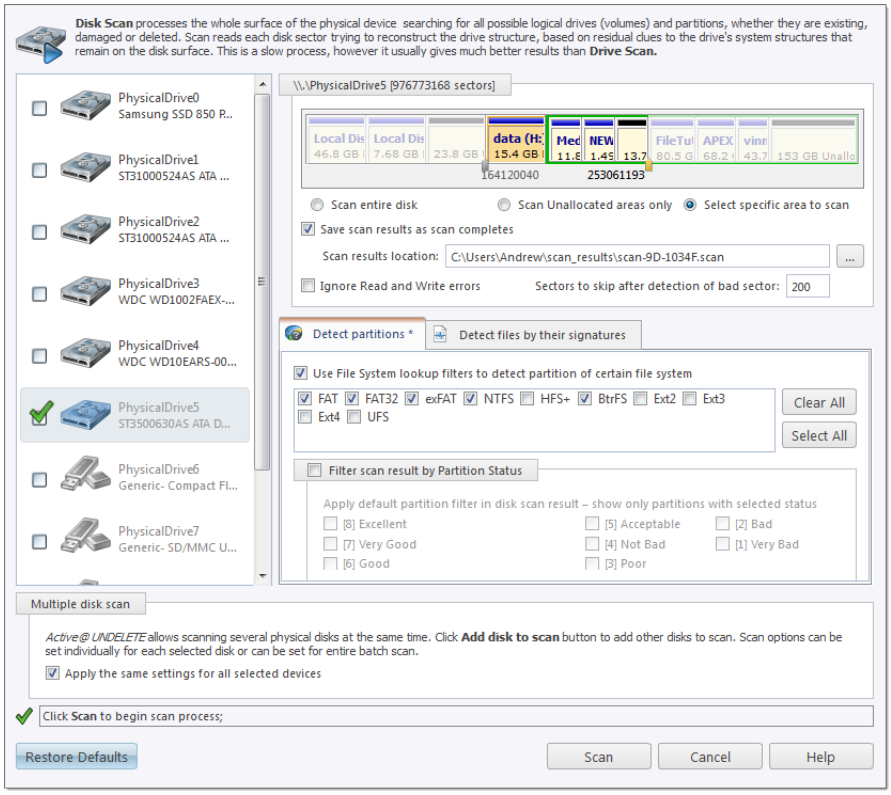
To scan a physical device for deleted partitions or files:

1. Initiate disk scan

   From **Recovery explorer**:

   - Click **Restore partitions** button in view's toolbar or
   - Select a disk (physical device) item and click **Scan** button in view's toolbar or
   - Use **Scan** command from context menu
   - Double-click and disk (physical device) node
2. Specify scan attributes

   Define scan range and other scan attributes if necessary.


Disk Scan processes the whole surface of the physical device searching for all possible logical drives (volumes) and partitions, whether they are existing, damaged or deleted. Scan reads each disk sector trying to reconstruct the drive structure, based on residual clues to the drive's system structures that remain on the disk surface. This is a slow process, however it usually gives much better results than Drive Scan.
PhysicalDrive0 Samsung SSD 850 P...
PhysicalDrive1 ST31000524AS ATA ...
PhysicalDrive2 ST31000524AS ATA ...
PhysicalDrive3 WDC WD1002FAEX-...
PhysicalDrive4 WDC WD10EARS-00...
PhysicalDrive5 ST3500630AS ATA D...
PhysicalDrive6 Generic- Compact Fl...
PhysicalDrive7 Generic- SD/MMC U...
\\.\PhysicalDrive5 [976773168 sectors]
Local Dis 46.8 GB
Local Dis 7.68 GB
23.8 GB
data (H: 15.4 GB
Med 11.8
NEW 1.45
13.7
FileTul 80.5 G
APEX 68.2
vinn 43.7
153 GB Unallo
164120040
253061193
Scan entire disk
Scan Unallocated areas only
Select specific area to scan
Save scan results as scan completes
Scan results location: C:\Users\Andrew\scan_results\scan-9D-1034F.scan
Ignore Read and Write errors
Sectors to skip after detection of bad sector: 200
Detect partitions *
Detect files by their signatures
Use File System lookup filters to detect partition of certain file system
FAT FAT32 exFAT NTFS HFS+ BtrFS Ext2 Ext3 Ext4 UFS
Clear All
Select All
Filter scan result by Partition Status
Apply default partition filter in disk scan result – show only partitions with selected status
[8] Excellent
[7] Very Good
[6] Good
[5] Acceptable
[4] Not Bad
[3] Poor
[2] Bad
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Multiple disk scan
Active@ UNDELETE allows scanning several physical disks at the same time. Click Add disk to scan button to add other disks to scan. Scan options can be set individually for each selected disk or can be set for entire batch scan.
Apply the same settings for all selected devices
Click Scan to begin scan process;
Restore Defaults
Scan
Cancel
Help

Figure 18: Disk Scan dialog

Scan area selector

Select scan area using predefined options: *entire disk*, *unallocated only* or *specific range* - use arrow markers to mark scan area;

Note: Scan area markers shown first and last sectors of scanning area. To enter exact start and end sectors to scan click on sector label and enter exact value in text field;

Save Scan results

Enter path, where scan results will be saved as soon as scan completed;

Ignore Errors

Ignore disk Read/Write Errors;

Sectors to skip

Amount of sectors to skip in case of read errors. Use this attribute to avoid scan prolonging on massive bad sectors arrays.

Detect partitions

Select desired **File System** of a partitions to be detected;

Detect files by their signatures

Select this option to specify exact file types to be detected during the scan. With this option, device scan reads each disk sector trying to reconstruct any possible data related to unique file format.

Important: Turn this option off when you only want to detect and restore partition - it will significantly save your scanning time.

Scan results filter

Define scan results refining filter by partition integrity status.

Multiple drive selection

Additional disks can be selected to scan on the **Physical disks** list to be scanned simultaneously. At least one disk must be selected.

Apply the same settings to all selected devices

All scan options above, can be selected for each drive individually or, when this check box is selected, to be the same for all selected logical drives.

Click **Scan** to initiate scan of selected disks.

3. Scan selected disks

During the scan:

- To display or hide scanning events and progress details toggle **More\Less Info** button at any time.
- To terminate the scan process, click **Stop** at any time. Results may be not accurate or complete.

After the scan completes you will see scan results in the *Work with device scan results* on page 19.

A Logical Drive scan result appears in the *Device scan result view* where results can be reviewed and files selected for recovery.

Note: We recommend you to save scan results to designated location for later use - you can use saved scan results to save time on repeated scanning of same volume.

Work with device scan results

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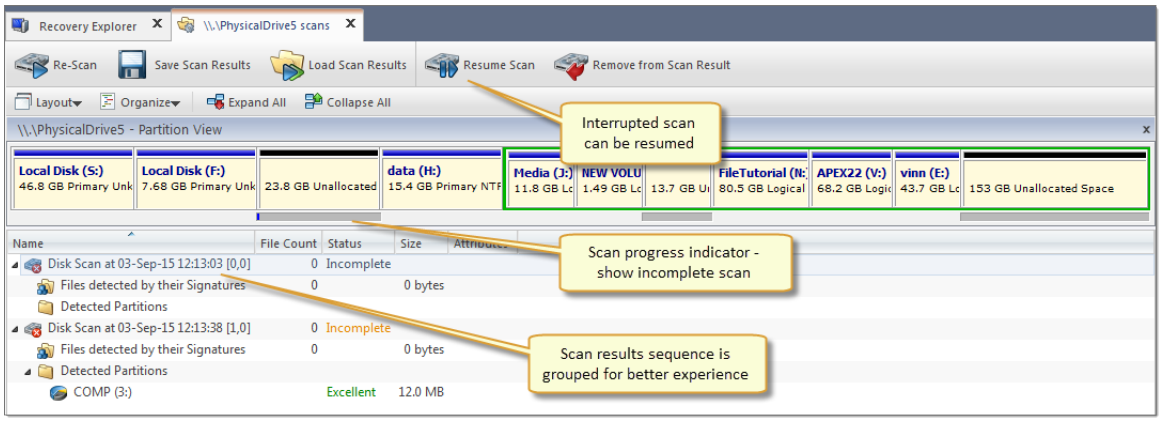


Figure 19: Interrupted Physical Device Scan

Device scan history

Show or hide device scan tree panel used for navigation of left side of a view. Use **Layout** > **Device scan history** menu commands from view's toolbar to toggle this option.

Organize files

Use feature to group detected files by:

- File extension;
- Associated application;
- Date (created, accessed and modified);
- and more.

Read *File Organizer* on page 114 article for detailed information about grouping sets and customization.

Expand All

Expand all scan result groups

Collapse All

Collapse all items to scan result groups

Tip: It is highly recommended to save scan results for later use: *Using scan results* on page 33

Re-scan

Context data storage device (disk) *can be rescanned* with different attributes and scan boundaries. All new results will appear in a same view under new scan result group for better results comparison and organization for recovery.

Save and load scan results

Scan results can be saved individual for later use. Read *Preserve scan results* on page 34 article for details.

Device Partition view control

In Device Scan view, scanned devices represented by **Device view control**. For each selected scan, Device View control shows scan progress indicator: blue stripe means scan is incomplete and solid green stripe - scan is complete for selected range. All interrupted (incomplete) scans can be resumed by clicking **Resume** button in view's toolbar or by command **Resume Scan** in item context menu.

If detected partition is selected, its relative position and scanned size is also displayed on Device View Control indicating is this partition is recoverable or not.

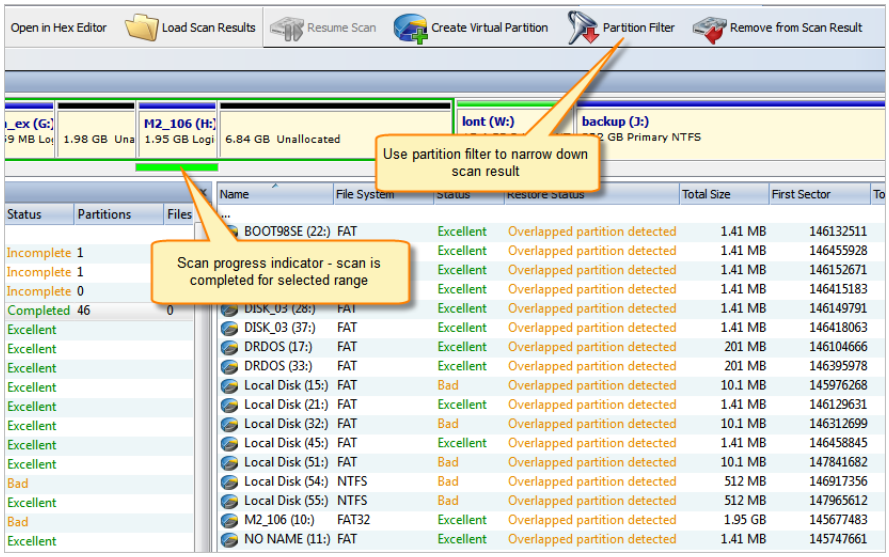

Open in Hex Editor
Load Scan Results
Resume Scan
Create Virtual Partition
Partition Filter
Remove from Scan Result
M2_106 (H:)
1.95 GB Logi
6.84 GB Unallocated
lont (W:)
backup (J:)
Use partition filter to narrow down scan result
Scan progress indicator - scan is completed for selected range
Status
Partitions
Files
Name
File System
Status
Restore Status
Total Size
First Sector
BOOT98SE (22:) FAT Excellent Overlapped partition detected 1.41 MB 146132511
DISK_03 (37:) FAT Excellent Overlapped partition detected 1.41 MB 146418063
DRDOS (17:) FAT Excellent Overlapped partition detected 201 MB 146104666
DRDOS (33:) FAT Excellent Overlapped partition detected 201 MB 146395978
Local Disk (15:) FAT Bad Overlapped partition detected 10.1 MB 145976268
Local Disk (21:) FAT Excellent Overlapped partition detected 1.41 MB 146129631
Local Disk (32:) FAT Bad Overlapped partition detected 10.1 MB 146312699
Local Disk (45:) FAT Excellent Overlapped partition detected 1.41 MB 146458845
Local Disk (51:) FAT Bad Overlapped partition detected 10.1 MB 147841682
Local Disk (54:) NTFS Bad Overlapped partition detected 512 MB 146917356
Local Disk (55:) NTFS Bad Overlapped partition detected 512 MB 147965612
M2_106 (10:) FAT32 Excellent Overlapped partition detected 1.95 GB 145677483
NO NAME (11:) FAT Excellent Overlapped partition detected 1.41 MB 145747661

Figure 20: Complete Physical Device Scan

Working with detected partitions

Detected partitions displayed with their status to be recovered and overall partition integrity. When partition *Recover Status* is "Can be recovered" then this partition can be restored as part of disk partitioning. To restore detected partition select it in view and click **Restore** button in view's toolbar or use **Restore** command from item's context menu.

Read *Restore detected partition* on page 32 article for exact procedure.

If partition cannot be restored by any reason, data from this partition still can be recovered. To do so, partition must be scanned (as regular Logic Drive) and files needs to be selected individually and recovered to safe location.

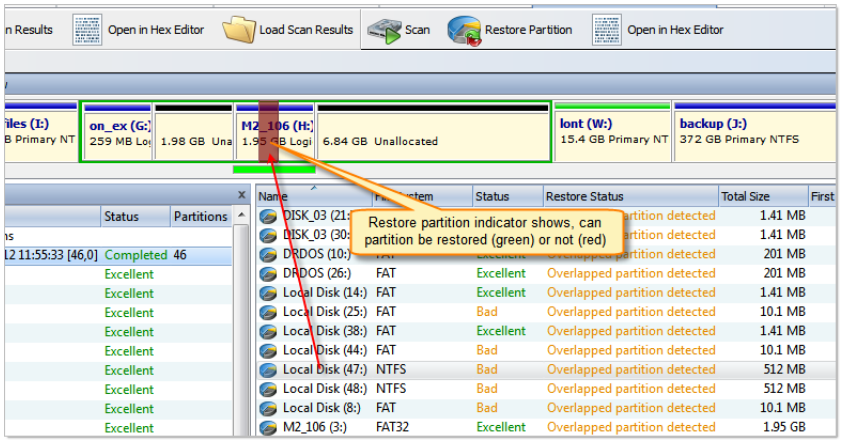


Figure 21: Detected partition indicator

For deeper analysis of detected partition you can also:

Scan

Scan detected partition to evaluate validity if its content.

Edit boot records

Edit partition attributes before restoring.

Open in Disk Editor

Open partition in Disk Editor - advanced hexadecimal build-in disk editor.

Working with files detected by signatures

Files detected by signatures are shown under related disk scan item and combined in groups by signature type (default). Original file names can not be recovered due to feature limitations, however they can generated in meaningful pattern by using file attribute meta tags in *File Organizer* on page 114 tool.

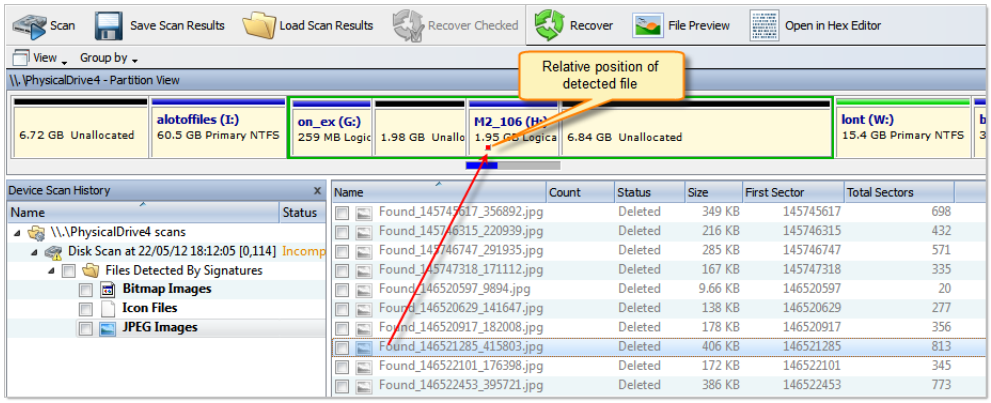


Figure 22: File Detected by signatures

Read *Recover detected files* on page 24 article for exact recovery steps.

Edit the boot sector template in detected partition

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

It may be necessary for you to edit detected partition attributes directly when some attributes are detected incorrectly or need adjustments.

Any detected partition can be cloned (virtually copied) before manually altering partition attributes and properties. We recommend that you edit the clone rather than directly edit the original partition. Any detected partition can be cloned as any times as you want.

To edit detected partition:

1. Select detected partition

   Select a detected partition in the scan results tree.
2. Open **Edit Boot Sector Template** dialog box

   - From the view toolbar click **Edit Boot Records** button
   - Right-click the selected partition and click **Edit Boot Records...** from the context menu.
3. Edit partition attributes

   Change partition attributes as needed. Read *Edit boot sectors* on page 112 article for details.

Restore detected partition

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

We recommend that you restore a partition with a certainty status of **Acceptable** or higher.

Before you restore a partition, you may clone or edit the partition directly to adjust its properties.

Here are some rules to follow when restoring a partition:

Assigning a drive letter

- Be aware of the location of executable files or files required by the operating system. Many MS-DOS and Windows programs refer to a specific drive letter when describing a path to executable files.
- Drives A: and B: are usually reserved for floppy disk drives, but you can assign these letters to removable drives if the computer does not have a floppy disk drive.
- Hard disk drives in the computer receive letters C through Z, while mapped network drives are assigned drive letters in reverse order (Z through B).

Setting the partition as active

- You may set only a primary partition as active. You cannot set a logical drive (an extended partition) as active.
- To set a partition as active, the partition must have an MBR (Master Boot Record) as the first sector.
- A computer can only have one active partition per disk.
- The name commonly used for the partition that contains the start-up files is the boot partition. The name commonly used for the partition that contains the operating system files is the system partition.
- The system partition can never be part of a striped volume, spanned volume, or RAID-5 volume.
- The system partition must be a primary partition that has been marked as active for start-up purposes. It must be located on the disk that the computer accesses when starting up the system.
- There can be only one active system partition on a disk at a time.
- You may have multiple basic disks and each disk can have one active partition. However, the computer will only start from one specific disk. If you want to use another operating system, you must first mark its system partition as active before restarting the computer.
- You cannot mark an existing dynamic volume as active. However, you can convert a basic disk containing the active partition to a dynamic disk. After the disk is converted, the partition becomes a simple volume that is active. If the active partition is not the current system or boot partition it becomes a simple volume and loses its entry in the partition table. Therefore it can no longer be active.

Extended partition

- A computer can only have one extended partition per physical disk device.

- You cannot create an extended partition on a disk if it already has four primary partitions.

Restore partition

1. Select partition to restore

   Select a detected partition in the *Work with device scan results* on page 19. Consider partition recovery status and overlapping with existing once.

2. Initiate partition restore

   To open the **Restore Partition dialog**, do one of the following:

   - From the toolbar click the **Restore Partition** button or use the command action **Restore Partition** from the main menu.
   - Right-click the selected item and click the **Restore Partition** command from the context menu.

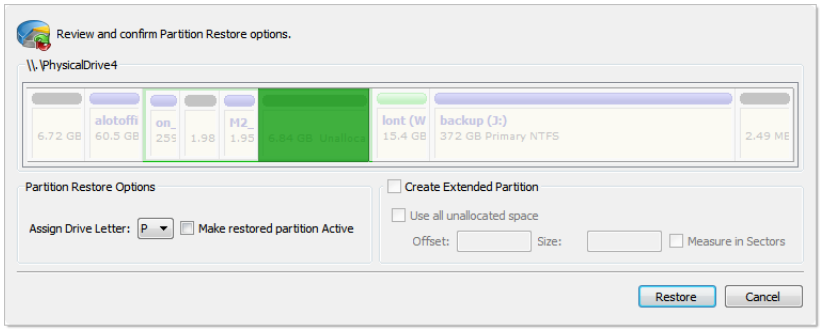


Figure 23: Restore partition dialog

Assign Drive Letter

To assign a drive letter to the recovered partition, select a letter from the drop-down list.

Make restored partition Active

To set this partition as active, check the **Make restored partition Active** check box.

Create Extended Partition

Before a partition is restored, unallocated space can be set as an extended partition by checking the **Create Extended Partition** check box.

3. Click **Restore** button

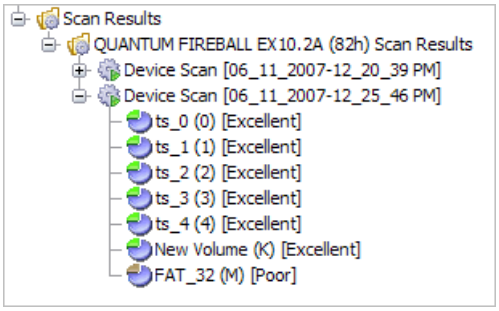
If partition restore successfully it should become accessible for default OS file explorer.

Using scan results

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Scan results of *physical disks* (storages) or *logical drives* (volumes) are shown in dedicated tabbed views, that has advanced tools to analyse, sort and organize the results and preserve (save) them for later use.

After you have completed a device scan, a Scan Results branch appears in the Recovery Explorer tree. Detected partitions are listed in order of their certainty of recovery.



There are 12 attributes that define a partition. In some cases, the application cannot be certain that the found item actually is a partition. The rating in the order of certainty depends on how many attributes are found and what condition they are in. You may perform the following actions on partitions in the Scan Results branch:

- *Stop and resume interrupted scan* on page 35
- *Filter detected partitions by certainty* on page 39
- *Save and Load scan results*

Preserve scan results

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

It can take a long time to run a default disk scan or a low level disk scan. Because you are dealing with a large volume of information, you might not be able to review all the data in one session.

So that you do not have to scan a *volume* or *physical disk* again, you can save and re-use valuable scan results.

You can save **Scan Results** branch or make a separate save for each disk scan or save all scans set for a particular device.

Scan results are saved with the file extension **`.scaninfo`**.

Warning: Save a scan results file to a physical drive that is different from the drive that was scanned.

Remember: Due to continuous activity on disk (volume) data saved in scan results become none synchronous with actual information on disk and become obsolete. Using old saved scan results may lead to unpredicted behaviour.

Preserving and using scan results for volumes and physical disks is slightly different.

Volume scan results

Physical disk scan results

Save Scan Results

1. To save the entire **Scan Results** branch, select the branch.
2. To save a device node, select it under **Scan Results**.
3. Right-click the selected node and click **Save Scan Result** from the context menu. The **Save Scan Result** dialog appears with the default path and a suggested file name.
4. To change the file path, browse to a different folder.
5. To change the file name, enter a name in the file name field.
6. Click **Save**.

Load Scan Results

1. To open the **Load Scan Results** dialog, do one of the following:

- From the File menu, click **Open** > **Scan Result…**
- Right-click the logical drive node and click **Load Scan Result** from the context menu.
- If there is a **Scan Results** branch in the **Recovery Explorer** tree, right-click the **Scan Results** branch or right-click a **Scan Results** node and click **Load Scan Result** from the context menu.

2. Browse to the folder that contains the scan result file and select the file.
3. Click **Open**.

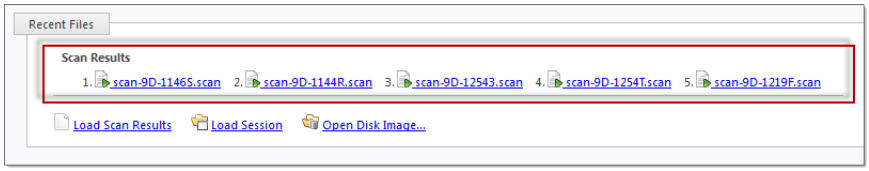


Figure 24: Load scan shortcuts on Welcome View

The data from the scan results file appears in a Scan Results node in the **Recovery Explorer** tree.

Note: Loading scan results feature is not available in `Active@ UNDELETE Freeware or Standard` edition. Please visit *http://www.active-undelete.com* to read more about Active@ UNDELETE Professional and Ultimate editions

Remove Scan Results

Data in the **Scan Results** branch is copied from the original physical device. You may remove any node – including detected partitions - from the Scan Results branch without harming the data on the original physical device.

To remove scan results:

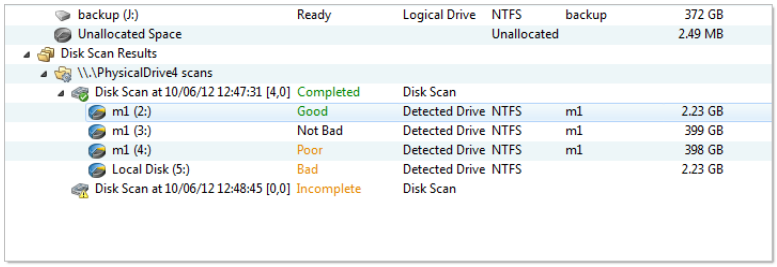
1. To remove the entire **Scan Results** branch, select the branch.
2. To remove a device node, select it under **Scan Results**.
3. Right-click the selected node and click **Remove Scan Result** from the context menu.

The selected node is removed from the **Recovery Explorer** tree.

Stop and resume interrupted scan

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

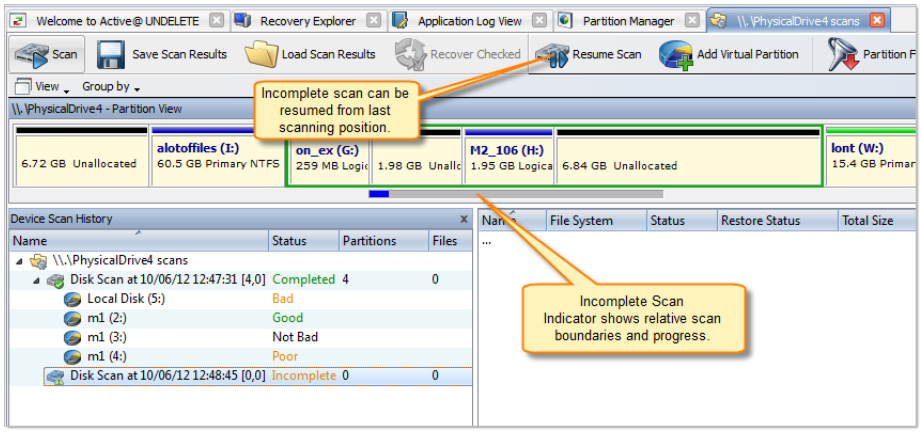
To stop a physical device scan at any time, press **Stop**. After you stop a scan, a **Scan Results** branch appears in the **Recovery Explorer** tree.


backup (J:) Ready Logical Drive NTFS backup 372 GB
Unallocated Space Unallocated 2.49 MB
Disk Scan Results
\\.\PhysicalDrive4 scans
Disk Scan at 10/06/12 12:47:31 [4,0] Completed Disk Scan
m1 (2:) Good Detected Drive NTFS m1 2.23 GB
m1 (3:) Not Bad Detected Drive NTFS m1 399 GB
m1 (4:) Poor Detected Drive NTFS m1 398 GB
Local Disk (5:) Bad Detected Drive NTFS 2.23 GB
Disk Scan at 10/06/12 12:48:45 [0,0] Incomplete Disk Scan

The example above shows how incomplete scan results are indicated. An icon appears next to each node in the Scan Results branch.

Incomplete Device Scan

An incomplete (interrupted) device scan can be resumed at any time.

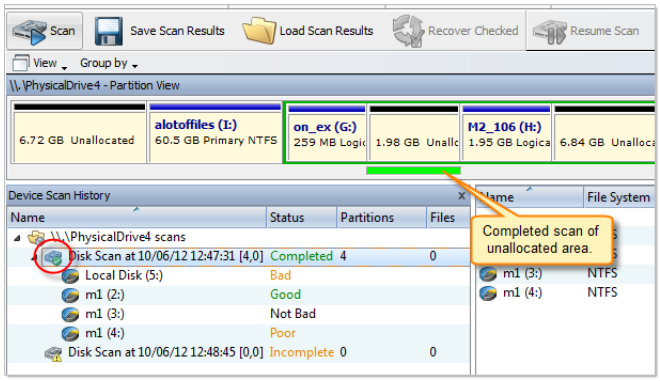


To resume a terminated scan:

1. Select a device scan result under the **Scan Results** branch.
2. To resume the scan, do one of the following:
   - From the toolbar, click the **Resume Scan** button.
   - Right-click the selected device scan and click **Resume Scan** from the context menu.

Completed Device Scan

A completed device scan cannot be resumed.



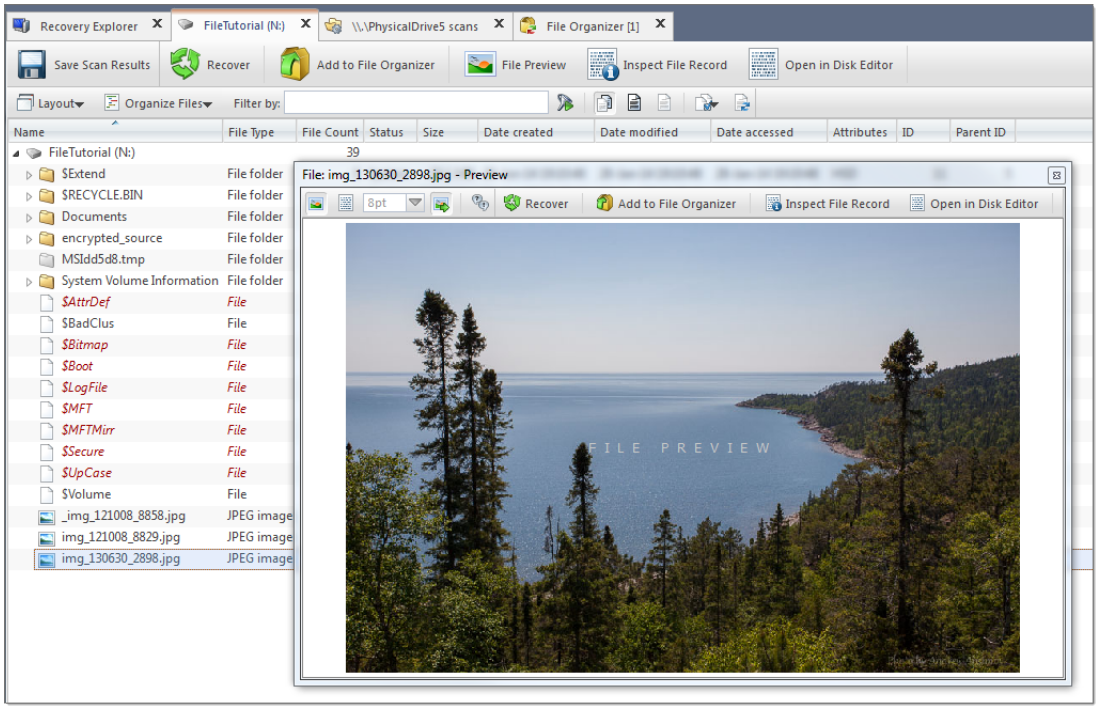
File preview

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

File Preview allows you to view the contents of an image file (**jpg**, bmp, gif, png etc.) or document before you recover the file.

To open the File Preview panel from any view, do one of the following:

- Double-click an image file.
- Right-click an image file and click **File Preview** from the context menu.
- Select an image file and click **File Preview** from the main toolbar.



Preview mode

Default preview mode can be selected either as *Hexadecimal* or *Rendered*, in which case file will be shown as an image (for graphics files) or rendered by one of the registered file previewers.

Font size

Select size of the font for hexadecimal mode;

Auto-follow

With this option **on** files, selected in context source, will be previewed automatically. Toggle this option **off** if for any reason file preview causes delays in file navigation.

Info

In this mode, all registered previewers and supported graphics formats in current system will be shown.

Recover

Recover previewed file to safe location.

Add to File Organizer

Add previewed file to *File Organizer* on page 114 tool.

Inspect file record

Inspect file record in Disk Editor.

Open in Disk Editor

Edit selected file in Disk Editor.

Note: If the preview file is not an image file, it appears in hexadecimal and text mode.

Supported file types

By default, File preview can preview contents of following file types:

- Microsoft Windows bitmap image file [.bmp];
- GIF File Format [.gif]
- ICO File Format[.ico]
- JPEG File Interchange Format [.jpeg]
- JPG File Interchange Format[.jpg]

- Multiple-image Network Graphics [.mng]
- Portable Bitmap Utilities File Format [.pbm, .pgm]
- Portable Network Graphics File Format [.png]
- Netpbm color image format [.ppm]
- Scalable Vector Graphics File [.svg, .svgz]
- Truevision TGA File Format [.tga]
- Tagged Image File Format [.tif, .tiff]
- Monochrome bitmap forma [.xbm]
- X Window System image [.xpm]

In windows OS, if registered document previewers are available, File Preview use OS-integrated file preview engines and allows to preview files such as MS Office Documents, RTF texts, PDF document or even small media files. Supported file types for preview are vary for each operating system. Use **Info** toolbar's toggle to show all registered File Previewers.

File filter toolbar control

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

The **File Filter toolbar** is used to organize files in related control - file list or file browser.

Case sensitive

Consider case in file filtering

Hide Empty Folders

Hides folders, if their has no filtered files.

By default, the results of a scan contain all files and folders. Use commands in the **File filter toolbar** to make a large list of files smaller and easier to read.

File Filter Toolbar is used in the following views:

- *Recovery Explorer view* on page 8
- *Work with logical drive scan results* on page 16
- *Search results view* on page 42
- *File Organizer view* on page 116

The filtered result may be applicable over an entire list (for example in *Search results view* on page 42) of within a selected folder (for example in *Recovery Explorer view* on page 8).

Using File Filter Toolbar

Enter filter pattern in text field and press **ENTER** key on keyboard pr click **Apply Filter** button in toolbar. File filter toolbar accepts wildards in filter patterns. Toolbar also remembers the user's search history so the user can easily repeat his search at any time.

For example, if you want to find PNG files on the specific drive you will need to select that drive and type ***.png** in the toolbar and click on **Apply Filter** button.

Use semi-column to apply multiple filter criteria, for example: to filter in only PNG and JPG files type in toolbar ***.png;*.jpg** and press either **ENTER** or click on the **Apply Filter** on the right side of the toolbar.

- To display an unfiltered list, click **Show All Files and Folders** button.
- To display only existing files and folders, click **Show only existing Files and Folders** button.
- To display only deleted files and folders, click **Show only deleted Files and Folders** button.
- To further reduce the size of a list, enter a pattern in File Filter field and press **ENTER** key on keyboard. The list displays only those files that match the pattern.

Wildcards

A *wildcard* is a character that can be used as a substitute for any of a class of characters in a search. Wildcard characters are often used in place of one or more characters when you do not know what the real character is or you do not want to enter the entire name. In Active@ UNDELETE three types of wildcard are used: **star** or asterisk(*), **question mark** (?) and **number sign** (#).

Examples of using wildcards:

Wildcard character	Example	Description
Asterisk (*)	docum*	Use the asterisk as a substitute for zero or more characters if you are looking for a file that you know what it starts with and you cannot remember the rest of the file name. The example locates all files of any file type that begin with **"docum"** including *documents.txt*, *document_01.doc* and *documentum.doc*.
	docum*.doc	To narrow the search to a specific type of file, include the file extension. The example locates all files that begin with **"docum"** and have the file name extension **.doc**, such as *document_01.doc* and *documentum.doc*.
Question mark (?)	doc?.doc	Use the question mark as a substitute for a single character in a file name. In the example, you will locate the file *docs.doc* or *doc1.doc* but not *documents.doc*.
Number sign (#)	doc_###.doc	Use the number sign (also known as the pound or hash sign) as a substitute for a single number in a name. In the example, you will locate the file *doc_012.doc* or *doc_211.doc* but not *doc_ABS.doc*.

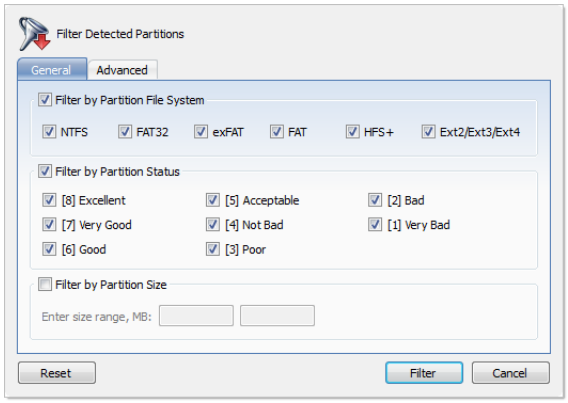
Filter detected partitions by certainty

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

After you complete a scan, detected partitions are listed in order of their certainty status based on attributes and validation level. To make a long list of partitions easier to read, remove partitions with a status of Bad and lower using a filter. To filter detected partitions:

1. Select scan result

   In the *Device scan results view* select a scan result node with detected partitions.
2. Open the **Filter Detected Partition** dialog:
   - From the toolbar, click Partition Filter.
   - Right-click the partition and click Partition Filter from the context menu.
3. Set filter values



Filter by Partition File System

Select the file system that will remain in the filtered partition list.

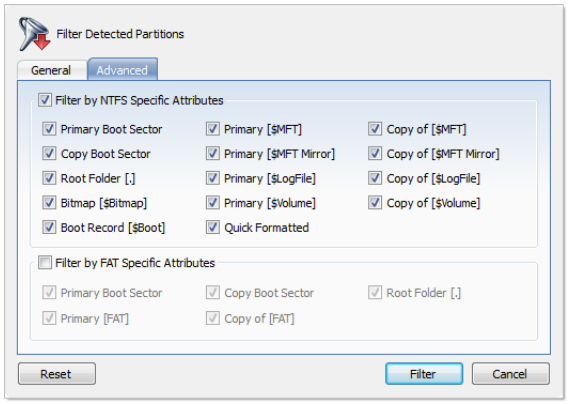
Filter by Status

Select the partition integrity statuses that will remain in the filtered partition list.

Filter by Size

To restrict the size of a partition to display, click the Filter by Partition Size check box and enter the lowest and highest partition size in MB.

Advanced tab filtering will let you filter a partition with specific NTFS or FAT attributes.



Press **Reset** in the **Filter Detected Partition** dialog to cancel partition filtering.

4. Click **Filter** to apply filter criteria

List of partitions with attributes that matches selected filter criteria will be shown in result view. Use **Reset** filter command to return partition list to original state.

Search for deleted files and folders

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

To help you find deleted files in a long list of files from a scanned drive, you may search the list with specific search criteria and review results in a *Search for deleted files and folders* on page 40.

1. Select a scanned logical drive or scanned detected partition
2. To open the **Search for Files and Folders** dialog box, do one of the following:

- From the main toolbar, click **Search**.
- Right-click the selected item and click **Search** from the context menu.

3. Provide general search criteria

   Enter search criteria in Look for and other search options (if required) and click Search button to start searching in selected location.

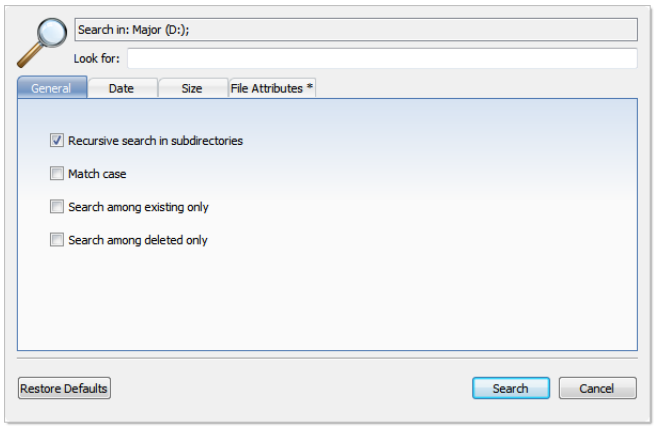


Figure 25: General Search Options

Recursive search in subdirectories

Use this option to search the root level of the drive and all sub folders. To search only the root folder, clear this check box.

Match case

To display files that match upper and lower case letters in the Look for field, select the Match case check box.

Search among existing only

To display only files that are not deleted, select the Search among existing only check box.

Search among deleted only

To display only files that are deleted or damaged, select the Search among deleted only check box.

4. Set date search criteria [optional]

To display files by a specified date, in the **Date Criteria** tab, in the **Date Type** drop-down list, choose a type and select a date range.

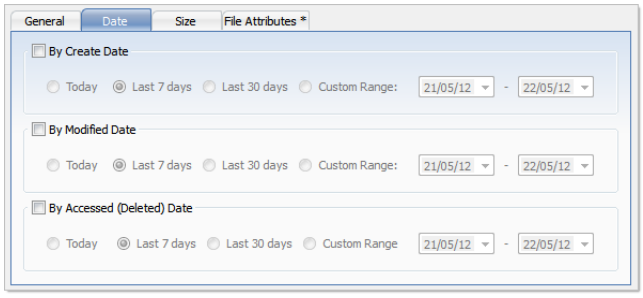


Figure 26: Date Criteria

5. Set file size criteria [optional]

To display files by a specified file size, in the **Size** tab, select Small, Medium or Large, or specify the size range in KB.

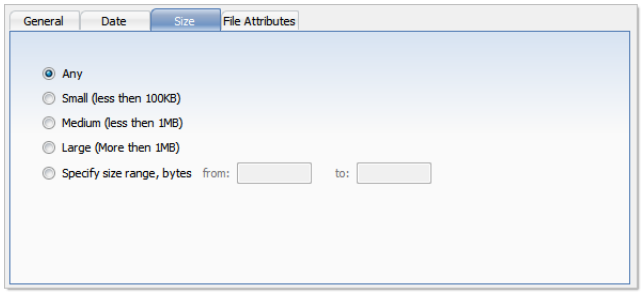


Figure 27: File Size Criteria

6. Set file attributes criteria [optional]

   To display files based on file attributes in, the **File Attributes** tab select file attributes that should be present (Include Files and Folders Attributes) or otherwise exempt (Exclude Files or Folders with Attributes) in search result.

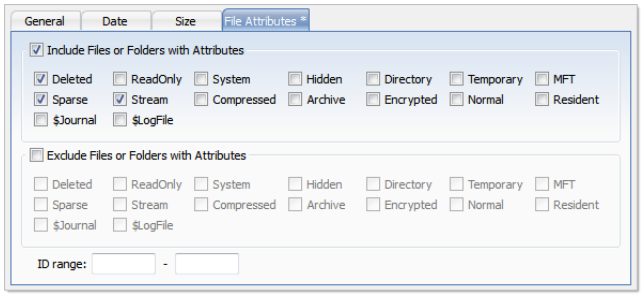


Figure 28: File Attributes Criteria

   To change all settings back to defaults, click **Restore Defaults**.

7. Click **Search** to start searching process

   To display disk image events and progress details, click **Details**. To terminate the searching process, click **Stop** at any time. In this case search results may be not accurate or complete. After the search is done, a *Search Results view* appears.

   Note: You may repeat a search many times and refine the search criteria for better results.

   Note: See *Searching patterns* on page 126 for details how to set search criteria. You may use *File filter toolbar control* on page 38 to improve search results.

After search complete, *Search results view* on page 42 must appear with search results (if any for provided criteria). You can repeat steps form 1 to 4 for desired effect.

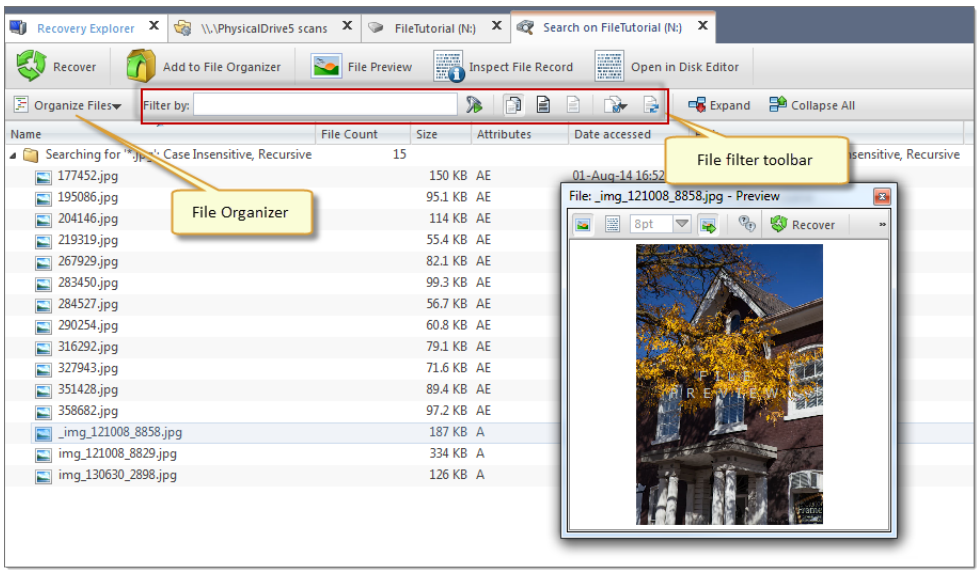
Search results view

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

The **Search Results view** appears after you perform a *Search for deleted files and folders* on page 40. The top panel displays the results of the search in a list.

To make this list easier to read, you may do the following:

- To sort the list by a column in ascending order, click the column header.
- To sort the list by the same column in descending order, click the column header a second time.
- To show a list that is reduced in size by a filter, select one of the preset options in the File Filter toolbar.



To recover an item in this list, right-click the item and choose **Recover** from the context menu or click **Recover** button in toolbar.

To preview an item, select it and click **File Preview**.

To change search criteria and repeat the search at the same location, click Search Again.

Note: You can create a custom filter for this list. For more information see *File filter toolbar control* on page 38.

Note: For information about how to start a search, see *Search for deleted files and folders* on page 40

File signatures

Introduction

`Active@ UNDELETE` comes with more than fifty predefined (internally programmed, very fast) file signatures to be used to detect particular files (MS Office Documents, many Image formats, ZIP archives, MP3, etc. during disk scan.

However sometimes advanced users need to detect more specific file formats, not being defined in default signatures set. For that purpose - custom file signature can be defined by defining file beginning and file length criteria. See *Custom (user defined) file signature templates* on page 43 article for details.

Custom (user defined) file signature templates

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Active@ UNDELETE offers advanced tools to define user's templates for signatures to be analyzed. Signatures can be defined using extended definition language RegExp (Regular Expressions).

To define custom signature template:

1. Open Preferences dialog

   Click **Tools** > **Preferences** command to open Preferences dialog
2. Add new custom signature
   - Click **Add** button to define new custom file signature.
   - Click **Import** button to load (import) custom file signature from script file (*.ini format). See *Custom file signature size script* on page 46 for details.

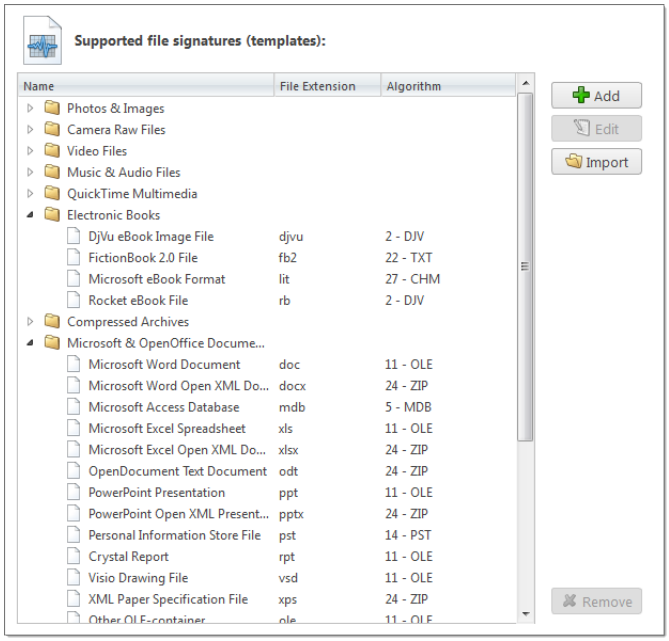

Supported file signatures (templates):
Name
File Extension
Algorithm
Photos & Images
Camera Raw Files
Video Files
Music & Audio Files
QuickTime Multimedia
Electronic Books
DjVu eBook Image File djvu 2 - DJV
FictionBook 2.0 File fb2 22 - TXT
Microsoft eBook Format lit 27 - CHM
Rocket eBook File rb 2 - DJV
Compressed Archives
Microsoft & OpenOffice Docume...
Microsoft Word Document doc 11 - OLE
Microsoft Word Open XML Do... docx 24 - ZIP
Microsoft Access Database mdb 5 - MDB
Microsoft Excel Spreadsheet xls 11 - OLE
Microsoft Excel Open XML Do... xlsx 24 - ZIP
OpenDocument Text Document odt 24 - ZIP
PowerPoint Presentation ppt 11 - OLE
PowerPoint Open XML Present... pptx 24 - ZIP
Personal Information Store File pst 14 - PST
Crystal Report rpt 11 - OLE
Visio Drawing File vsd 11 - OLE
XML Paper Specification File xps 24 - ZIP
Add
Edit
Import
Remove

Figure 29: Supported file signatures

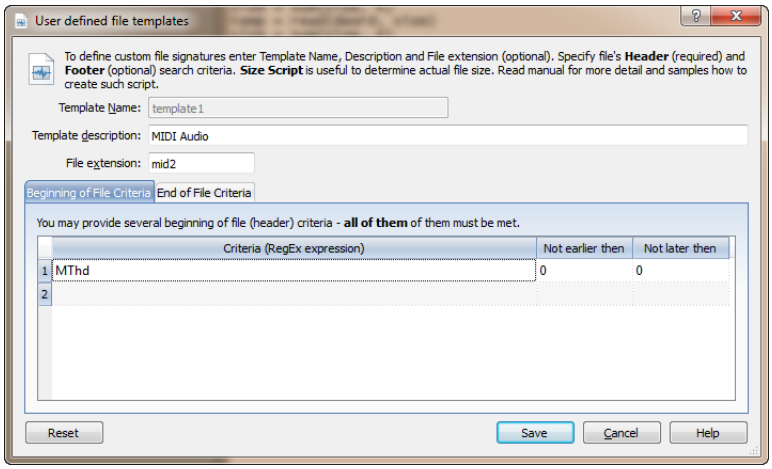
Note: You can edit your custom file signature template at any time by selecting your template in list and clicking **Edit** button or simply double-clicking on template's name.

3. Edit file signature template

   Use *Edit file signature template* on page 44 dialog to define starting signature criteria ans file length (file end) criteria of signature template.

Edit file signature template

Provide template name and brief description - for future references. Specify file extension of a file type you defining (optional). To completely define custom file signature template you need to enter Header (beginning of the file) and Footer (end of the file) criteria using RegExp syntax. Header criteria could be more then one and all of them must be met to consider beginning of the file. Footer's criteria could more then one too, but at least one of them must be met to consider end of file.


User defined file templates
To define custom file signatures enter Template Name, Description and File extension (optional). Specify file's Header (required) and Footer (optional) search criteria. Size Script is useful to determine actual file size. Read manual for more detail and samples how to create such script.
Template Name: template1
Template description: MIDI Audio
File extension: mid2
Beginning of File Criteria
End of File Criteria
You may provide several beginning of file (header) criteria - all of them of them must be met.
Criteria (RegEx expression)
Not earlier then
Not later then
1 MThd 0 0
2
Reset
Save
Cancel
Help

Template name

Unique template name.

Template description

Brief template description (optional)

File extension

File extension for this template (optional)

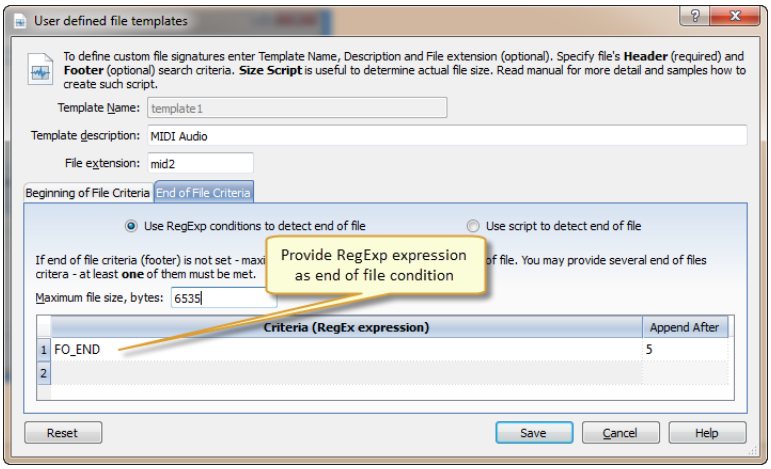
Beginning of File Criteria

List of RegEx criteria, considered as beginning of file combined as AND statements. Not earlier then and Not later then specifies limits of defined criteria in the beginning of a file template.

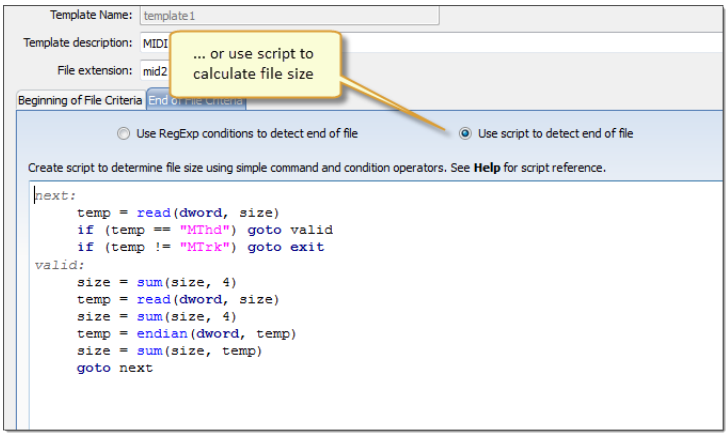
End of File Criteria

End of files can be determined in two ways:

- By list of RegEx criteria, considered as end of file combined as OR statements. In case of missing file footer criteria, end of file will be taken by defined Maximum file size. Append after attribute specifies size of end of a file. File size is used in case of missing file end criteria. By default its 65535 bytes.


User defined file templates
To define custom file signatures enter Template Name, Description and File extension (optional). Specify file's Header (required) and Footer (optional) search criteria. Size Script is useful to determine actual file size. Read manual for more detail and samples how to create such script.
Template Name: template1
Template description: MIDI Audio
File extension: mid2
Beginning of File Criteria
End of File Criteria
Use RegExp conditions to detect end of file
Use script to detect end of file
Provide RegExp expression as end of file condition
Maximum file size, bytes: 6535
Criteria (RegEx expression)
Append After
1 FO_END 5
2
Reset
Save
Cancel
Help

- By using simple script to calculate end of file. See *Custom file signature size script* on page 46 for reference.


Template Name: template1
Template description: MIDI
File extension: mid2
... or use script to calculate file size
Beginning of File Criteria
Use RegExp conditions to detect end of file
Use script to detect end of file
Create script to determine file size using simple command and condition operators. See Help for script reference.
next:
temp = read(dword, size)
if (temp == "MThd") goto valid
if (temp != "MTrk") goto exit
valid:
size = sum(size, 4)
temp = read(dword, size)
size = sum(size, 4)
temp = endian(dword, temp)
size = sum(size, temp)
goto next

Defined custom file signatures templates are stored in INI files in user's selected locations and will be loaded at every consequent application starts. You can also import such custom signature template files created by other users by clicking Import button and specifying full path to custom file signatures template file in opened dialog. See *Custom file signature size script* on page 46 for details.

Note: Also you can specify Custom File signature template from Volume (logical Drive) Scan dialog or Disk Scan dialog by clicking **Add** button near file signatures list.

Important: Regular Expressions can be used while defining signature headers and footers. Please check *RegExp syntax on a web for examples* .

Custom file signature size script

Custom signatures file size calculation syntax.

Custom (User Defined) File Signatures are saved in text file and can be edited by using simple text editor (like notepad) or by using Active@ UNDELETE tool: *Custom (user defined) file signature templates* on page 43.

User defined template reference

- Empty lines and lines starting with semicolon are ignored
- Sections order and lines order in sections are not important
- Letter case is not important (except RegExp fields)

Section TEMPLATES - required and contains fields numbering from one;

TEMPLATE### - points to the section where signature template is described (numbered from one).

Section **Template Header** - required and contains fields:

BEGIN

required. Points to the section describing begin of the signature file

FOOTER

non required. Points to the section describing end of the signature file

MAX_SIZE

non required. Maximum file size to force file-end, if no file-end signature is detected. By default it is 64Kb

GROUP

non required. If missed - template goes to User Defined templates group by default

DESCRIPTION

non required. This is a descriptive name of user template being displayed on a screen

EXTENSION

non required. This is a file extension to be assigned and displayed

SCRIPT

non required. Refers to the section where size of the file being calculated

Note: If field **SCRIPT** is present, then field **FOOTER** is ignored in template header section.

Beginning of the file section

Section describing file beginning (required), contains fields of the same type:

```
<signature> = <offset_start> | <offset_end>
```

signature

expression (regular or Reg Exp-compatible). Expression max length is 1024 bytes

offset_start

acceptable minimal signature offset from the beginning of the file

offset_end

acceptable maximum signature offset from the beginning of the file

Note: If there are several fields listed in signature beginning, logical AND operation applied to confirm file start.

End of file section

Section describing file end (not required), contains fields of the same type:

```
<signature> [= <bytes_to_append>]
```

signature

expression (regular or RegExp-compatible). Expression max length is 1024 bytes

bytes_to_append

not required. How many bytes to append to the file after the signature is found

Note: If there are several fields listed in signature, logical OR operation applied to define file end.

File size calculation script

Section calculating file size (not required), contains operators of four types:

```
<result> = <command> (<argument>, <argument>)
<result> = <argument>
IF (<argument> <condition> <argument>) GOTO <label>
GOTO <label>
```

commands

READ, ENDIAN, SUM, SUB, MUL, DIV, SHR, SHL, AND, OR and XOR

Most of commands are the same as in assembler programming language, except:

READ - first argument - data type (size) to be read, second - offset from the beginning of the file

ENDIAN - first argument - data type (size), second - expression, which byte order will be swapped

First argument for commands READ and ENDIAN must be one of reserved data types: BYTE, WORD, DWORD, QWORD

argument

can be either a named variable or a constant

result

can be the only named variable

condition

can be one of : < <= == >= > != (meaning is the same as in C++)

label

consists of label name followed by colon and it can precede any operator

Note:

- Label named *EXIT* has been reserved and instructs to complete the calculations
- Named variable *SIZE* has been reserved and keeps the file size
- Constants can be in Decimal form, Binary (followed by 'b'), Octal ('o'), and Hexadecimal ('h') or can be a text string

```
[TEMPLATES]
TEMPLATE1 = PRIMITIVE_HTML
TEMPLATE2 = PRIMITIVE_JPG
TEMPLATE3 = QBW_HEADER
TEMPLATE4 = CHM_HEADER
TEMPLATE5 = SWF_HEADER
TEMPLATE6 = PST_HEADER
TEMPLATE7 = MRW_HEADER
TEMPLATE8 = MID_HEADER
TEMPLATE9 = CAB_HEADER
```

```
TEMPLATE10 = BMP_HEADER
TEMPLATE11 = DJV_HEADER

[PRIMITIVE_HTML]
DESCRIPTION = Primitive HTML Signature
EXTENSION = html
BEGIN=HTML_BEGIN
FOOTER=HTML_FOOTER
MAX_SIZE = 655360

[HTML_BEGIN] <html = 0 | 512 <head = 0 | 1024
[HTML_FOOTER] </html> = 2
[PRIMITIVE_JPG]
BEGIN=BEGIN.TEST.JPG
GROUP = Images and Camera RAW files
DESCRIPTION = Primitive JPG files
FOOTER=FOOTER-.TEST.JPG
EXTENSION = test.jpg
MAX_SIZE = 3221225472


[BEGIN.TEST.JPG]
\xFF\xD8\xFF = 0 | 0

[FOOTER-.TEST.JPG]
\xFF\xD9

[DJV_HEADER]
DESCRIPTION=DjVu Document
EXTENSION=djvu
BEGIN=DJV_BEGIN
SCRIPT=DJV_SCRIPT

[DJV_BEGIN]
AT&TFORM=0|0

[DJV_SCRIPT]
  size = read(dword, 8)
  size = endian(dword, size)
  size = sum(size, 12)

[QBW_HEADER]
DESCRIPTION=QuickBooks Document
EXTENSION=qbw
BEGIN=QBW_BEGIN
SCRIPT=QBW_SCRIPT

[QBW_BEGIN]
MAUI=96|96

[QBW_SCRIPT]
  data = read(dword, 36)
  temp = read(dword, 52)
  if (temp <= data) goto exit
  size = sum(temp, 1)
  size = shl(size, 10)

[CHM_HEADER]
DESCRIPTION=Microsoft CHM Help
EXTENSION=chm
BEGIN=CHM_BEGIN
SCRIPT=CHM_SCRIPT

[CHM_BEGIN]
```

```
ITSF=0|0

[CHM_SCRIPT]
  version = read(dword, 4)
  if (version == 0) goto exit
  header = read(dword, 8)
  if (header <= 1Ch) goto exit
  temp = read(qword, header)
  if (temp != 1FEh) goto exit
  temp = sum(header, 8)
  size = read(qword, temp)
  temp = sum(header, 10h)
  if (size > temp) goto exit
  size = 0

[SWF_HEADER]
DESCRIPTION=Adobe Flash SWF
EXTENSION=swf
BEGIN=SWF_BEGIN
SCRIPT=SWF_SCRIPT

[SWF_BEGIN]
FWS=0|0

[SWF_SCRIPT]
  data = read(byte, 3)
  if (data <= 10h) goto exit
  size = read(dword, 4)
  if (size <= 8) goto exit
  size = 0

[PST_HEADER]
DESCRIPTION = Outlook Archive
EXTENSION = pst
BEGIN = PST_BEGIN
SCRIPT = PST_SCRIPT

[PST_BEGIN]
!BDN=0|0

[PST_SCRIPT]
  data = read(byte, 10)
  if (data == 0Eh) goto valid
  if (data != 17h) goto exit
  size = read(dword, 184)
  goto exit
valid:
  size = read(dword, 168)

[MRW_HEADER]
DESCRIPTION = Minolta Camera Images
EXTENSION = mrw
BEGIN = MRW_BEGIN
SCRIPT = MRW_SCRIPT

[MRW_BEGIN]
\x00MRM=0|0

[MRW_SCRIPT]
  data = read(dword, 4)
  if (data == 0) goto exit
  width = read(word, 24)
  if (width == 0) goto exit
  width = endian(word, width)
```

```
  height = read(word, 26)
  if (height == 0) goto exit
  height = endian(word, height)
  pixel = read(byte, 32)
  if (pixel == 0) goto exit
  pixel = mul(pixel, width)
  pixel = mul(pixel, height)
  pixel = div(pixel, 8)
  size = endian(dword, data)
  size = sum(size, pixel)
  size = sum(size, 8)

[MID_HEADER]
DESCRIPTION = MIDI Audio
EXTENSION = mid
BEGIN = MID_BEGIN
SCRIPT=MID_SCRIPT

[MID_BEGIN]
MThd=0|0
[MID_SCRIPT]
next:
  temp = read(dword, size)
  if (temp == "MThd") goto valid
  if (temp != "MTrk") goto exit
valid:
  size = sum(size, 4)
  temp = read(dword, size)
  size = sum(size, 4)
  temp = endian(dword, temp)
  size = sum(size, temp)
  goto next

[CAB_HEADER]
DESCRIPTION=Microsoft Compressed Archive CAB
EXTENSION=cab
BEGIN=CAB_BEGIN
SCRIPT=CAB_SCRIPT

[CAB_BEGIN]
MSCF=0|0

[CAB_SCRIPT]
  version = read(word, 24)
  if (version != 103h) goto exit
  folders = read(word, 26)
  folders = mul(folders, 8)
  folders = sum(folders, 36)
  files = read(word, 28)
  files = mul(files, 16)
  files = sum(files, folders)
  temp = read(dword, 16)
  if (temp < folders) goto exit
  temp = read(dword, 8)
  if (temp <= files) goto exit
  flags = read(word, 30)
  flags = and(flags, 4)
  if (flags == 0) goto skip
  flags = read(dword, 36)
  if (flags != 20) goto skip
  flags = read(dword, 44)
  if (flags < temp) goto skip
  size = flags
  temp = read(dword, 48)
```

```
skip:
  size = sum(temp, size)

[BMP_HEADER]
DESCRIPTION = Bitmap Images BMP
EXTENSION = bmp
BEGIN=BMP_BEGIN
SCRIPT=BMP_SCRIPT

[BMP_BEGIN]
BM=0|0

[BMP_SCRIPT]
  width = read(dword, 12h)
  if (width == 0) goto exit
  height = read(dword, 16h)
  if (height == 0) goto exit
  pixel = read(word, 1ch)
  if (pixel == 1) goto valid
  if (pixel == 4) goto valid
  if (pixel == 8) goto valid
  if (pixel == 16) goto valid
  if (pixel == 24) goto valid
  if (pixel != 32) goto exit
valid:
  pixel = mul(pixel, width)
  pixel = mul(pixel, height)
  pixel = div(pixel, 1000b)
  rastr_size = read(dword, 22h)
  if (rastr_size < pixel) goto exit
  rastr_offset = read(dword, 0Ah)
  if (rastr_offset < 38) goto exit
  rastr_offset = sum(rastr_offset, rastr_size)
  size = read(dword, 2)
  if (size >= rastr_offset) goto exit
  size = 0
```

Supported file signatures

Photos & Images

- Bitmap Image [*.bmp]
- Paintbrush Bitmap Image [*.pcx]
- JPEG Image [*.jpg]
- Icon File [*.ico]
- Windows Animated Cursor [*.ani]
- Graphical Interchange Format [*.gif]
- Portable Network Graphics [*.png]
- Multiple-image Network Graphics [*.mng]
- CorelDRAW Image [*.cdr]
- Tagged Image [*.tif]

Camera Raw Files

- Canon Raw Image [*.cr2]
- Canon Raw CIFF Image [*.crw]
- Digital Negative Image [*.dng]
- Fuji FinePix Raw Image [*.raf]

- Hasselblad 3F Raw Image [*.3fr]
- Kodak Photo-Enhancer [*.kdc]
- Kodak RAW Image [*.dcr]
- Konica Minolta Raw Image [*.mrw]
- Leaf Aptus Raw Image [*.mos]
- Leica Raw Image [*.raw]
- Mamiya Raw Image [*.mef]
- Nikon Raw Image [*.nef]
- Olympus Raw Image [*.orf]
- Panasonic LX3/LX5 Raw Image [*.rw2]
- Pentax Raw Image [*.pef]
- Seiko Epson Raw Image [*.erf]
- Sigma Raw Image [*.x3f]
- Sony Digital Camera Image [*.arw]
- Sony SR2 Raw Image [*.sr2]
- Sony SRF Raw Image [*.srf]
- Samsung Raw Image [*.srw]

Video Files

- Advanced Systems Format [*.asf]
- Audio Video Interleave [*.avi]
- Autodesk Animation [*.fli]
- Autodesk Animation Pro [*.flc]
- Flash Video File [*.flv]
- Matroska Video File [*.mkv]
- MPEG Video File [*.mpeg]
- MPEG (RIFF) File [*.mpg]
- MPEG Transport Stream [*.mts]
- Material Exchange Format File [*.mxf]
- Red Core Digital Cinema Camera [*.r3d]
- Rich Media Format File [*.rm]
- Rich Media Format File (VBR) [*.rmvb]
- Windows Media Video [*.wmv]

Music & Audio Files

- Simple Audio File [*.au]
- Audio Interchange File [*.aiff]
- Compressed Audio Interchange File [*.aifc]
- Advanced Audio Coding File [*.aac]
- Monkey's Lossless Audio File [*.ape]
- Free Lossless Audio Codec [*.flac]
- MIDI File [*.mid]
- Synthetic Music Mobile File [*.mmf]
- MP3 Audio File [*.mp3]
- Ogg Vorbis Compressed Audio [*.ogg]
- Rich Music Format File [*.ra]
- WAVE Audio File [*.wav]
- Windows Media Audio File [*.wma]
- WavPack Correction Audio Stream [*.wvc]

QuickTime Multimedia

- QuickTime 3G2 Multimedia File [*.3g2]
- QuickTime 3GP Multimedia File [*.3gp]
- QuickTime CDC Multimedia File [*.cdc]
- QuickTime DRM Multimedia File [*.dcf]
- QuickTime F4V Multimedia File [*.f4v]
- QuickTime JP2 Multimedia File [*.jp2]
- QuickTime JPA Multimedia File [*.jpa]
- QuickTime JPM Multimedia File [*.jpm]
- QuickTime JPX Multimedia File [*.jpx]
- QuickTime M4A Multimedia File [*.m4a]
- QuickTime M4B Multimedia File [*.m4b]
- QuickTime M4P Multimedia File [*.m4p]
- QuickTime M4V Multimedia File [*.m4v]
- QuickTime MAF Multimedia File [*.maf]
- QuickTime MOV Multimedia File [*.mov]
- QuickTime MP4 Multimedia File [*.mp4]
- QuickTime MPG Multimedia File [*.mpg]
- QuickTime MQV Multimedia File [*.mqv]
- QuickTime SDV Multimedia File [*.sdv]

Electronic Books

- DjVu eBook Image File [*.djvu]
- FictionBook 2.0 File [*.fb2]
- Microsoft eBook Format [*.lit]
- Rocket eBook File [*.rb]

Compressed Archives

- 7-Zip File Archive [*.7z]
- ARC File Archive [*.arc]
- ARJ File Archive [*.arj]
- Windows Cabinet Archive File [*.cab]
- GNU Zipped File Archive [*.gz]
- LZH File Archive [*.lzh]
- TAR Archive File [*.tar]
- WinRAR File Archive [*.rar]
- Zipped File Archive [*.zip]
- ZOO File Archive [*.zoo]

Microsoft Office & OpenOffice documents

- Microsoft Word Document [*.doc]
- Microsoft Word Open XML Document [*.docx]
- Microsoft Access Database [*.mdb]
- Microsoft Excel Spreadsheet [*.xls]
- Microsoft Excel Open XML Document [*.xlsx]
- OpenDocument Text Document [*.odt]
- PowerPoint Presentation [*.ppt]
- PowerPoint Open XML Presentation [*.pptx]
- Personal Information Store [*.pst]

- Crystal Report [*.rpt]
- Visio Drawing [*.vsd]
- XML Paper Specification [*.xps]
- Other OLE-container [*.ole]
- OpenDocument Graphics [*.odg]
- OpenDocument Presentation [*.odp]
- OpenDocument Spreadsheet [*.ods]
- OpenDocument Formula [*.odf]
- OpenDocument Database [*.odb]

Adobe Files

- Adobe Acrobat Document [*.pdf]
- Adobe Photoshop Document [*.psd]
- Adobe Shockwave Flash [*.swf]
- Adobe After Effect Project [*.aep]

FileMaker Platform

- FileMaker Pro 3.0 File [*.fp3]
- FileMaker Pro Database [*.fp5]
- FileMaker Pro Ver.7+ Database [*.fp7]
- FileMaker Pro Document [*.fmp12]

Formatted Text Files

- Hypertext Markup [*.htm]
- Compiled HTML Help [*.chm]
- Extensible Markup Language Document [*.xml]
- Rich Text Format [*.rtf]

Miscelanious

- QuickBooks Data File [*.qbw]
- CDFS Disk Image [*.iso]
- Stereolitography [*.stl]
- AutoCAD Drawing Database [*.dwg]
- Maxon Cinema 4D [.c4d]
- FireBird Database [.fdb]

Working with disk images

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Definition

Disk Image is a copy of your logical drive or physical device that is stored in one file. This can be useful when you want to backup the contents of the whole drive, and restore it or work with it later. Before you start recovering the deleted files, it may be a good idea to create a Disk Image for this drive, if you have enough space at another drive. Why? Because if you do something wrong while recovering the files (for example, recovering them onto the same drive could destroy their contents), you still will be able to recover these deleted files and folders from the Disk Image that you have wisely created.

Active@ UNDELETE provides extensive functionality to operate with Disk Images. You can create image of either Logical disk, Device or Partition. Save it as one large file or split on image chunks with size you prefer for later use.

When you creating Disk Image, it stores in at least two files: one is *Configuration file* with file extension .DIM and the second - actual image body file. If you decide to save disk image chopped on peaces (chunks) then image body files can be as many as its required to save data.

Here is an example: If you save a raw disk image with the name `MyImage`, the application creates a file named `MyImage.dim`. This is the configuration file. Data is stored in a file named `MyImage.dim.001`. If more than one file is created, the next file is named `MyImage.dim.002`, and so on. The data file can be split in several files – chunks that can be useful if you want to save the Disk Image on a CD or Data DVD.

When to use Disk Image

Raw disk images are very helpful in a data recovery. Here are some reasons why a raw disk image can be used for data recovery:

- Data recovery technologies are based on searching the unused space on a partition for traces of deleted, lost or damaged files and folders. So-called "unused space" on a partition is not recognized by the file system and is not saved to a regular disk image. However, this space does contain valuable data information and it is saved to a raw disk image.
- The uncompressed raw disk image file contains a sequence of sectors that is unchanged from the original. There are no headers or other application-specific identifiers added. As a result, the raw disk image can be viewed by any data rescue software as a mirror of your drive. If the integrity of the data on your live disk is questionable, you may want to experiment with the data on the partition image instead.
- If file size is an issue, a compressed raw image may be used. `Active@ UNDELETE` is an example of data recovery software which can work with both compressed and uncompressed raw images.
- Raw images have no regard for the file system type. During the raw disk image recording process, all sectors are backed up. An image of any partition can be restored by using `Active@ Disk Image` software.
- If you want the data from a file to be restored from the disk image to the same exact location as they were before, then use a raw disk image. A regular image saves all current data but restores files to different sectors, allowing the partition to shrink or grow, depending on the size of the replaced file. In a regular situation, you should not be concerned about partition size. If the partition size is important, however, a raw image is the solution.

Working with disk images

Disk image can be created directly from Recovery Explorer or by using dedicated *Disk Image Wizards*.

Create a Disk Image

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Using `Active@ UNDELETE` you can create a *Disk Image* of a *volume* (logical drive) or a *disk* (physical device). To create disk image:

1. Open the Create Disk Image dialog
   - From the **Recovery Explorer** toolbar, click **Create Disk Image** button or use command **Actions** > **Create Disk Image** from main menu;
   - Right-click the selected item and click **Create Disk Image** command from the context menu.
   - From the **Disk Images** tab in **Command Bar**, choose **Open Disk Image** command;
2. Specify Disk Image attributes

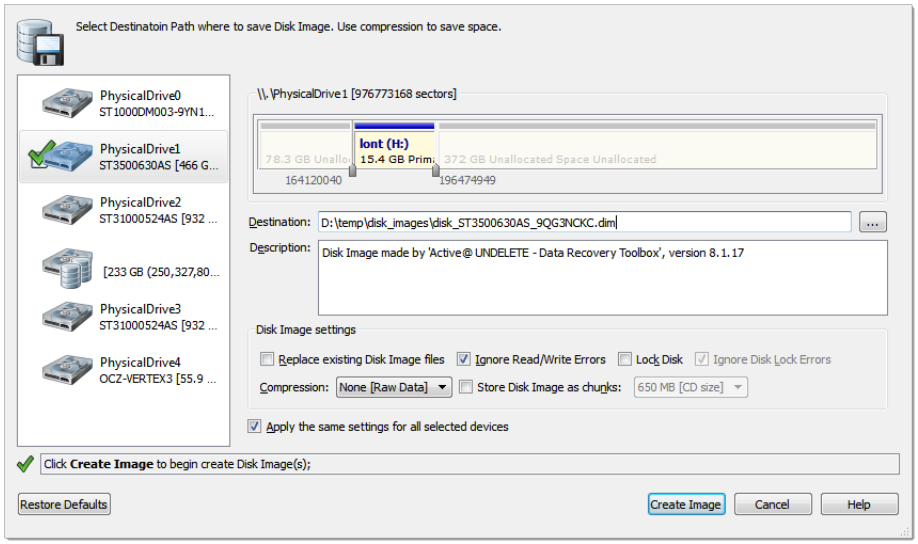


Figure 30: Create Disk Image dialog

Multiple disk selection

Additional areas on other disks can be selected in the **Physical Disks** list to be processed simultaneously. At least one selection must be made to begin disk image creation.

Disk Control

Use markers that indicates the first and last sectors on this control to specify an area to image.

Destination

Provide location of *Disk Image configuration file*. To browse to the path, click the ellipsis button […]. All Disk Image chunk files will be created in the same folder with DIM file.

Description

Enter a brief description about this disk image for future reference. Optional.

Replace existing disk image files

If this option is set, all chunk files will be replaced with a new once if their file names are the same.

Ignore R\W Errors

Ignore Read and Write errors during the disk image creation.

Lock Disk

Source disk will be locked until Disk Image creation is complete or aborted;

Ignore Disk Lock Errors

Any errors related to disk lock will be ignored;

Compression

Choose one of the following:

- **None [Raw Data]** - No compression is applied, sectors are stored in raw format.
- **Fast** - Sectors are compressed before storing to the file using a fast compression algorithm.
- **Medium** - Sectors are compressed before storing to the file using a slow but more effective compression algorithm.
- **High** - High level of compression;
- **Highest** - Highest possible compression level ill be used;

Store Disk Image in chunks

Select this check box to save the Disk Image as a series of files with a specified size. Choose the file size from the drop-down list. This option may be useful if you want to write the Disk Image to CD-ROMs or DVD-ROMs. By default this check box is cleared and the Disk Image is stored in one large file;

Click **Create Image** button to initiate disk image creation process with selected parameters

3. Create image

   During the process:

   - To display or hide scanning events and progress details toggle **More\Less Info** button at any time.
   - To terminate the process, click **Stop** at any time. Results may be not accurate or complete.

As a result, you will have one or several (depends on creation preferences) disk image files in your destination folder.

Note: The file extension for a Disk Image configuration file is .DIM by default.

Important: The Destination Path for a Disk Image file must always be on another drive. File systems such as FAT16 and FAT32 do not support file sizes larger than 2GB and 4GB respectively. With these file systems it is not possible to create a Disk Image file for a drive as it is likely to grow larger than the size limit. The solution in this case is to do one of the following:

- Use a Destination Path drive that is formatted using Windows NT, Windows 2000, Windows XP and using NTFS;
- Create a Disk Image that is split into chunks of an appropriate size, keeping within the limits set by the file system;

Tip: Use *Create a disk image wizard* on page 76 for the same purpose.

Open Disk Image

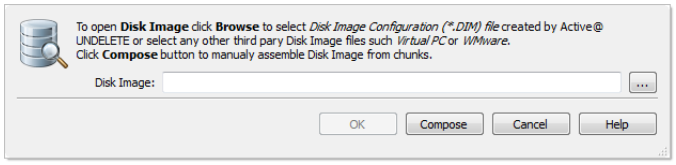
Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

You may open a *Disk Image* to browse for files and folders or to scan for deleted files and folders.

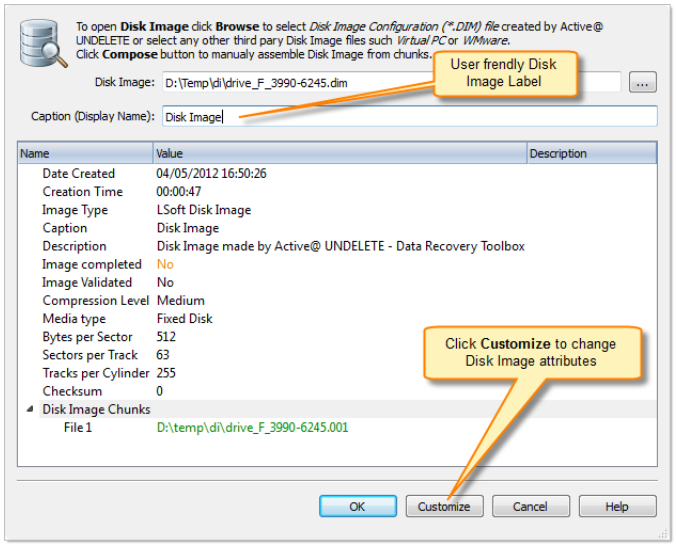
1. To open the Open Disk Image dialog, do one of the following:

   - From the **Disk Images** tab in **Command Bar**, choose **Open Disk Image** command;
   - From the main toolbar, click **File** > **Open** > **Open Disk Image**.
   - From **Welcome View**, click **Open Disk Image** button in **Default Actions** group;

2. Open disk image using Configuration file


To open Disk Image click Browse to select Disk Image Configuration (*.DIM) file created by Active@ UNDELETE or select any other third pary Disk Image files such Virtual PC or VMware.
Click Compose button to manualy assemble Disk Image from chunks.
Disk Image:
...
OK
Compose
Cancel
Help

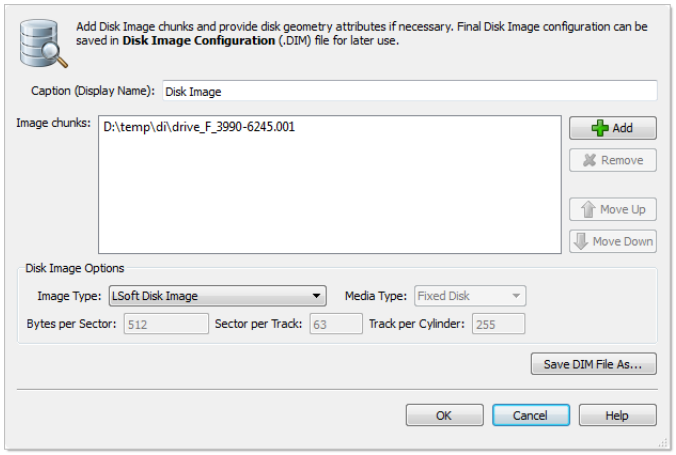
Use **Browse** button to locate .DIM (Disk Image Configuration) file. Once it selected, file ill be opened and presented with detailed preview of Disk Image information.


To open Disk Image click Browse to select Disk Image Configuration (*.DIM) file created by Active@ UNDELETE or select any other third pary Disk Image files such Virtual PC or VMware.
Click Compose button to manualy assemble Disk Image from chunks.
User frendly Disk Image Label
Disk Image: D:\Temp\di\drive_F_3990-6245.dim
Caption (Display Name): Disk Image
Name
Value
Description
Date Created 04/05/2012 16:50:26
Creation Time 00:00:47
Image Type LSoft Disk Image
Caption Disk Image
Description Disk Image made by Active@ UNDELETE - Data Recovery Toolbox
Image completed No
Image Validated No
Compression Level Medium
Media type Fixed Disk
Bytes per Sector 512
Sectors per Track 63
Tracks per Cylinder 255
Checksum 0
Disk Image Chunks
File 1 D:\temp\di\drive_F_3990-6245.001
Click Customize to change Disk Image attributes
OK
Customize
Cancel
Help

Click **OK** to open disk image or click **Compose** button to alter disk image configuration (see next step).

3. Compose Disk Image [optional]

If there is no DIM file for Disk Image or to open third party Disk Images click **Compose** button.


Add Disk Image chunks and provide disk geometry attributes if necessary. Final Disk Image configuration can be saved in Disk Image Configuration (.DIM) file for later use.
Caption (Display Name): Disk Image
Image chunks: D:\temp\di\drive_F_3990-6245.001
Add
Remove
Move Up
Move Down
Disk Image Options
Image Type: LSoft Disk Image
Media Type: Fixed Disk
Bytes per Sector: 512
Sector per Track: 63
Track per Cylinder: 255
Save DIM File As...
OK
Cancel
Help

Caption

Enter any label to distinguish newly opened disk image among other devices and disks.

Disk Image Chunks

A Disk Image consists of one or many files, which contains actual image data. A Disk Image can be cut into several files (chunks) during creation for better space allocation. In this list you have to specify all these files which make ups the image.

- To add a Disk Image chunk to the list click the **Add New** button and use browse for a file dialog to select a file.
- To remove a Disk Image chunk, select this chunk in the list and click the **Remove** button.
- To modify the order of Disk Image chunks, select any chunk you wish to relocate and use the **Up** and **Down** buttons to move a selected chunk in the chunk stack.

Image Type

Select image type you about to open. Usually it assigned automatically, depending on Disk Image chunks added.

- **Raw Disk Image** - Raw fragment of a disk;
- **LSoft Disk Image** - Disk Image created by any LSoft Technology product;

- **Virtual PC** - Disk Images from Virtual PC software;
- **VM Ware Image** - Disk Images from VM Ware software;

Media Type

Select appropriate media type. Usually it assign automatically. Use **Fixed Disk** by default.

Bytes per Sector

Enter sector size in bytes;

Sectors per Track

Enter track size in sectors;

Tracks per Cylinder

Enter cylinder size in tracks;

Save DIM File as...

In case of manual composition of Disk Image properties you may save final configuration file for later use;

4. Confirm and open disk image

   Click **OK** to open Disk Image.

   Important: Use *Open a disk image wizard* on page 78 for the same purpose.

If disk image opens successfully then disk image node appears in **Recovery Explorer**.

Verify Disk Image

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Created Disk Images can be verified for integrity check by using *Verify a disk image wizard* on page 79 or simply *opened* in Recovery Explorer and evaluated.

Using virtual storages

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

`Active@ UNDELETE` allows you to create virtual entities for better access - *virtual disks* and *virtual partitions* to emulate the real once without affecting data on physical devices. Thus, user can emulate actual physical disk by assigning different values of disk geometry properties and read data from device with different sequence and interpretation.

Besides direct emulation of physical disk or partition (volume) user can use disks (or part of them) and *disk images* to create *virtual RAIDS* - emulation of real physical disk array that allows to read data from disassembled RAID.

Create virtual disk **on page 59**

Using virtual disk will let you access actual data by using alternated disks geometry without a single modification on disk

Virtual partitions **on page 60**

Emulates disk partitioning for advanced data access.

Virtual RAID **on page 63**

Virtual disk assembly - emulation of real RAID controller for data access.

Create virtual disk

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Virtual disks can be used to mock real physical device with altering their attributes such as bytes per sector.

To create virtual disk in Active@ UNDELETE proceed as follows:

1. Select physical disk to emulate
   - In **Partition Manager** select physical device item in devices list or in Disk Navigator;
   - Select physical disk **Recovery Explorer**. Use *Expert device view*, *Partition view* or *Enhanced view* modes;
2. Open Create virtual disk dialog
   - Click **Create Virtual Disk** button in Partition Manager or in Recovery Explorer or use command **Actions** > **Create Virtual Disk** from main menu;
   - Right-click the selected item and click **Create Virtual Disk** command from the context menu.

   Enter disk caption to label new virtual disk in **Recovery Explorer**, sector size and boundaries of used space of actual physical disk.

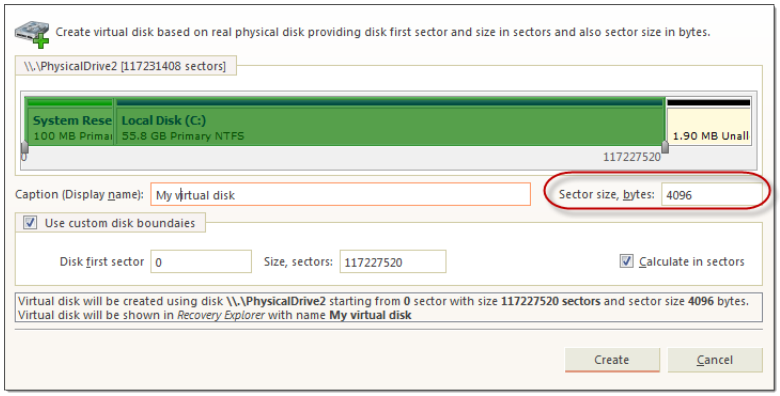

Create virtual disk based on real physical disk providing disk first sector and size in sectors and also sector size in bytes.
\\.\PhysicalDrive2 [117231408 sectors]
System Rese
100 MB Primai
Local Disk (C:)
55.8 GB Primary NTFS
1.90 MB Unall
117227520
Caption (Display name):
My virtual disk
Sector size, bytes:
4096
Use custom disk boundaies
Disk first sector
0
Size, sectors:
117227520
Calculate in sectors
Virtual disk will be created using disk \\.\PhysicalDrive2 starting from 0 sector with size 117227520 sectors and sector size 4096 bytes.
Virtual disk will be shown in Recovery Explorer with name My virtual disk
Create
Cancel

Figure 31: Create virtual disk dialog

Caption

Assign text label for virtual disk to recognize in Recovery Explorer. Optional.

Sector size

Sector size in bytes. By default original physical disk sector size is used.

First and last sector

Select virtual disk boundaries, by default - entire original physical disk is used.

3. Click **Create** button

Tip: You can create any number of virtual disks and they are saved in application session for later use.

Virtual disk should appear in Recovery Explorer in group of **Virtual Devices and Arrays**.

Virtual partitions

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Unlike *Create virtual disk* on page 59 a virtual logical partition emulates a real logical drive or partition using a assigned geometry values. If you have a logical drive that is recognized by Windows and you cannot access the data in that drive, you may be able to gain access to your data by creating a virtual partition copy and change its attributes to gain an access. Active@ UNDELETE allows you following actions with *virtual partitions*:

Create virtual copy of existing partition **on page 61**

Create virtual copy of real partition changing any attribute of its geometry without affecting disk partitioning.

Create virtual partition **on page 61**

Besides a copy of real partition or volume you can create custom partition linked to any physical device without changing data.

Edit virtual partition **on page 62**

You can change attributes of virtual partition at any time.

To delete virtual partition select it in **Recovery Explorer** and click **Delete** button in toolbar or use context menu command **Delete** or click **Del** key for the same purpose.

Create virtual copy of existing partition

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

1. Select a partition (volume)

   In **Recovery Explorer**, select a logical drive or a partition.
2. Open the Create Virtual Copy dialog
   - Use command **Actions** > **Create Virtual Partition** from main menu
   - Right-click the selected item and click **Create Virtual Partition** command from the context menu.
3. Adjust dialog options

   Partition to copy will be selected automatically. Use sliders to specify partition boundaries - offset and size. Mouse click on partition box will select virtual partition boundaries.

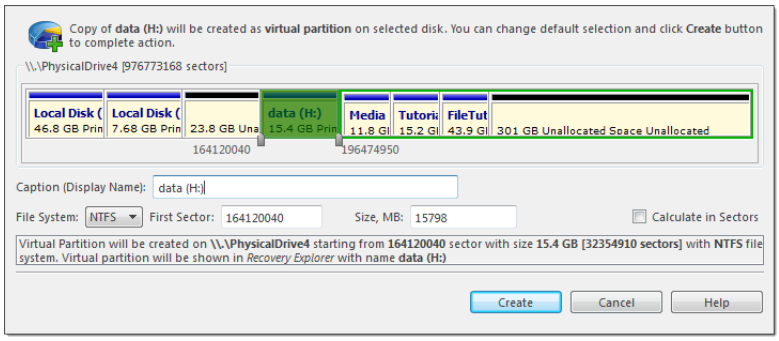


Figure 32: Create virtual copy dialog

Caption

Text label to mark created virtual partition in **Recovery Explorer** or in **Partition Manager**.

File system

Select file one of the supported file systems: FAT, FAT 32 or NTFS.

First sector

Offset of virtual partition in sectors or in MB.

Size

Size of virtual partition in sectors or in MB.

4. Click **Create** button

After command is complete, newly created virtual partition will appear in **Recovery Explorer** ready for applicable actions, such as volume scan etc.

Create virtual partition

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

To create virtual partition in Active@ UNDELETE proceed as follows:

1. Select disk (physical device)

- Select a disk (physical device) node in **Recovery Explorer**. Use *Expert Device View*, *Partition View* or *Enhanced View* modes.
- Select a disk (physical device) node **Partition Manager** device list or in **Disk Navigator** tree.

2. Open the Create Virtual Partition dialog
   - From the **Partition Manager** toolbar click **Create Virtual Partition** button.
   - Use command **Actions** > **Create Virtual Partition** from main menu
   - Right-click the selected item and click **Create Virtual Partition** command from the context menu.
3. Adjust dialog options

   Use sliders to specify partition boundaries - offset and size. Mouse click on partition box will select virtual partition boundaries.

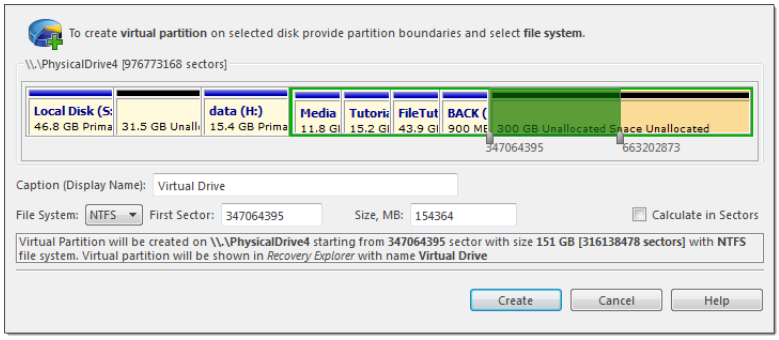


Figure 33: Create virtual partition dialog

Caption

Text label to mark created virtual partition in **Recovery Explorer** or in **Partition Manager**.

File system

Select file one of the supported file systems: FAT, FAT 32 or NTFS.

First sector

Offset of virtual partition in sectors or in MB.

Size

Size of virtual partition in sectors or in MB.

4. Click **Create** button

After command is complete, newly created virtual partition will appear in **Recovery Explorer** ready for applicable actions, such as volume scan etc.

Edit virtual partition

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Virtual partition properties can be changed without affecting actual data on disk.

1. Select a virtual partition

   In **Recovery Explorer**, select a logical drive or a partition.
2. Open the **Edit Boot Sector Template**
   - From the **Recovery Explorer** toolbar, click **Edit Partition**.
   - Right-click the selected item and click **Modify Partition** from the context menu.
3. Adjust dialog options

   In the **Edit Boot Sector Template dialog**, make changes to the *Boot Sector Primary* and *Boot Sector Copy* separately or simultaneously. See the *Edit boot sectors* on page 112 dialog for details.

4. Save changes

   Click **Save** button to accept changes

Virtual RAID

Virtual RAID

Virtual RAID is software mocking or real physical drives (disks) RAID assembly to access data on these disks. `Active@ UNDELETE` supports all major RAID types:

- Stripe RAID-0
- Mirror RAID-1
- RAID-5

Application also supports non-RAID arrays, like **spanning** of drives, when several disks are simple concatenated in a single big one.

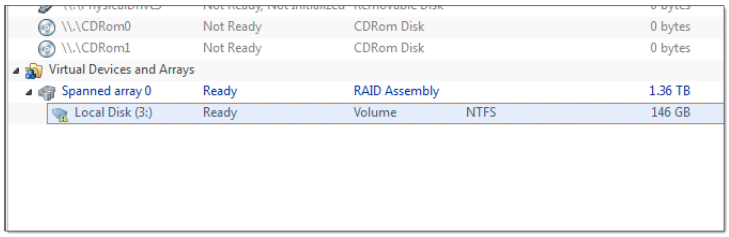


Figure 34: Virtual RAID item in Recovery Explorer example

Created virtual RAIDS appears in *Recovery Explorer view* on page 8 and can be handled as real disks with partitions and volumes for purpose of file recovery. Due to nature of these objects, partition restoration on them is impossible.

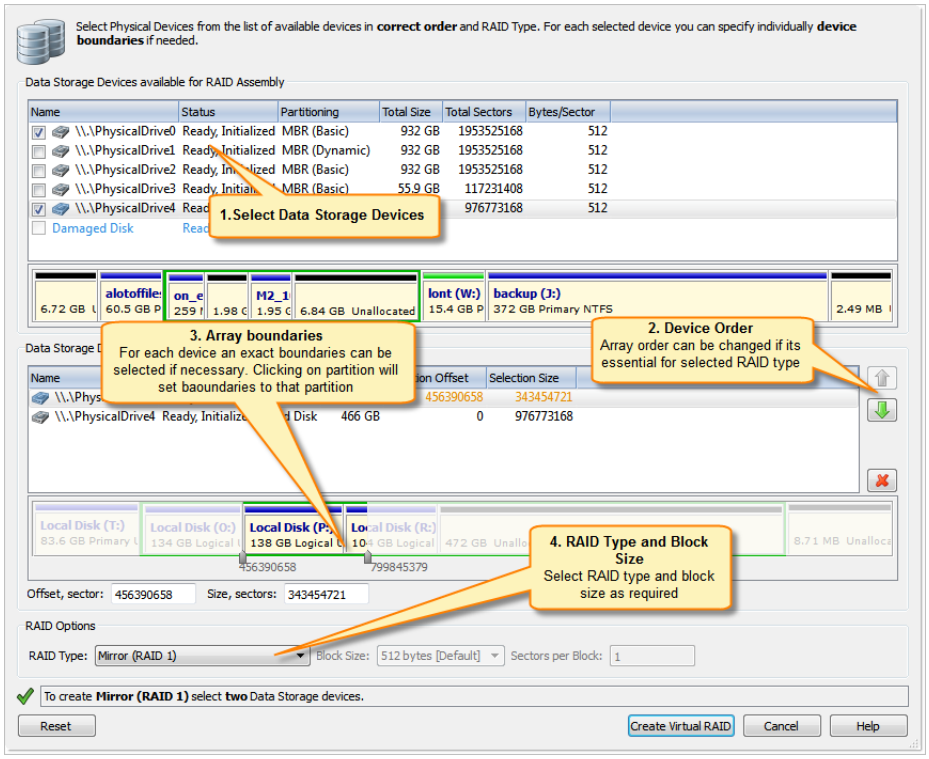
Virtual RAID Assembly

Active@ UNDELETE is an advanced data recovery toolset allows to reconstruct damaged or broken RAIDS.

Virtual RAID assemblies are used to recover files from damaged physical RAID. To assemble virtual RAID follow the steps:

1. Open the **Virtual Disk Array Assembly** dialog

   - From the **Tools** menu, choose **Create Virtual RAID** (RAID) command.
   - From the **Tools** tab in **Command Bar**, choose **Create Virtual RAID** command.


Select Physical Devices from the list of available devices in correct order and RAID Type. For each selected device you can specify individually device boundaries if needed.
Data Storage Devices available for RAID Assembly
Name
Status
Partitioning
Total Size
Total Sectors
Bytes/Sector
\\.\PhysicalDrive0 Ready, Initialized MBR (Basic) 932 GB 1953525168 512
\\.\PhysicalDrive1 Ready, Initialized MBR (Dynamic) 932 GB 1953525168 512
\\.\PhysicalDrive2 Ready, Initialized MBR (Basic) 932 GB 1953525168 512
\\.\PhysicalDrive3 Ready, Initialized MBR (Basic) 55.9 GB 117231408 512
\\.\PhysicalDrive4 Ready, Initialized 976773168 512
Damaged Disk
1. Select Data Storage Devices
6.72 GB
alotoffile:
60.5 GB P
on_e
259 M
1.98 G
M2_1
1.95 G
6.84 GB Unallocated
lont (W:)
15.4 GB P
backup (J:)
372 GB Primary NTFS
2.49 MB
3. Array boundaries
For each device an exact boundaries can be selected if necessary. Clicking on partition will set baoundaries to that partition
2. Device Order
Array order can be changed if its essential for selected RAID type
Selection Size
456390658
343454721
\\.\PhysicalDrive4 Ready, Initialized Disk 466 GB 0 976773168
Local Disk (T:)
83.6 GB Primary
Local Disk (O:)
134 GB Logical
Local Disk (P:)
138 GB Logical
Local Disk (R:)
472 GB Unallo
8.71 MB Unalloca
456390658
799845379
4. RAID Type and Block Size
Select RAID type and block size as required
Offset, sector: 456390658
Size, sectors: 343454721
RAID Options
RAID Type: Mirror (RAID 1)
Block Size: 512 bytes [Default]
Sectors per Block: 1
To create Mirror (RAID 1) select two Data Storage devices.
Reset
Create Virtual RAID
Cancel
Help

RAID Type

RAID type. See article: *Disk arrays (RAID's)* on page 144 for information about how to select proper RAID type.

Block size

Size of stripe block in bytes. Applicable only for stripe or RAID-5 array types.

Sectors per Block

Size of a block in sectors

Offset

Offset of selected disk area from beginning if a disk in sectors.

Size

Size of selected area in sectors.

2. Select and order source disks

To add disks to virtual RAID Assembly:

- Double-click a disk in the **Available disks** list to move it to the **Selected disks** list.
- Use check marks to add disk to the Selected disks list.

To remove disks from Selected disks list:

- Double-click a disk in the Selected disks list.
- Click a disk in the Selected disks list. To remove it, click **Remove**.
- To remove all disks from the **Selected disks** list, click **Remove All**.

3. Define disks order (optional)

To change the order of a disk in the Selected disks list, select it and click **Move Up** or **Move Down**.

4. Adjust disks boundaries (optional)

For each selected disks offset and size can be defined to specify part of a disk used in RAID assembly. By default entire disk is used in disk array.

Note: For each selected disk, used disk range can be set individually.

Tip: Click on disk partition or unallocated space to select entire partition or unallocated space to disk range for RAID assembly.

5. Specify the virtual array type

   Select one of the supported RAID types:

   - Simple volume;
   - Spanned array;
   - Mirror (RAID-1);
   - Stripe (RAID-0);
   - RAID-5 (left asynchronous) - default value;
   - RAID-5 (left synchronous);
   - RAID-5 (right asynchronous);
   - RAID-5 (right synchronous);

6. Set additional options (if required)

   - In **stripe block size** text box specify the stripe block size in kilobytes (Stripe and RAID-5 arrays only).
   - For RAID5 select a proper parity layout from drop-down list box. See *Disk arrays (RAID's)* on page 144 for parity layout reference.

7. Click Create Virtual RAID button

   The **Processing…** dialog appears.

   Note: To display creation events and progress details, click **Details**.

   Note: To terminate the creation process, click **Stop** at any time. Results may be not accurate or complete

As a result, assembled virtual RAID must appear in **Recovery Explorer** view as a device, ready for scan or other actions applicable for virtual devices.

If a virtual disk array is not created, or if it is created with errors, return to 1 and try again with different disks, or with a different disk order and RAID options.

Active@ UNDELETE wizards overview

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data. Various wizards will help you perform recovery task fast and easy.

`Active@ UNDELETE Wizards` are sets of step-by-step guided tools that help you to accomplish different recovery and disk management tasks.

Wizards can be started at any time from:

- Main application's menu **Wizards**;
- From **Welcome View** or
- From sliding **Command Bar** on lefts side of a main view.

Active@ UNDELETE has following wizards:

File Recovery Wizards

These wizards are used to recover files lost in different circumstances.

- *Recover deleted files wizard* on page 66
- *Recover files detected by their signatures wizard* on page 68
- *Recover files from a deleted partitions wizard* on page 74
- *Recover files from a formatted partition wizard* on page 72
- *Recover files from a damaged partition wizard* on page 70
- *Recover files from a physical disk wizard* on page 76

Partition Management Wizards

- *Create a new partition wizard* on page 82
- *Restore a deleted partition wizard* on page 81

Disk Image Wizards

- *Create a disk image wizard* on page 76
- *Open a disk image wizard* on page 78
- *Verify a disk image wizard* on page 79

Advanced

- *Create a virtual RAID wizard* on page 83

File recovery wizards

Recover deleted files wizard

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

A wizard designed to recover accidentally deleted files from existing logical drives.

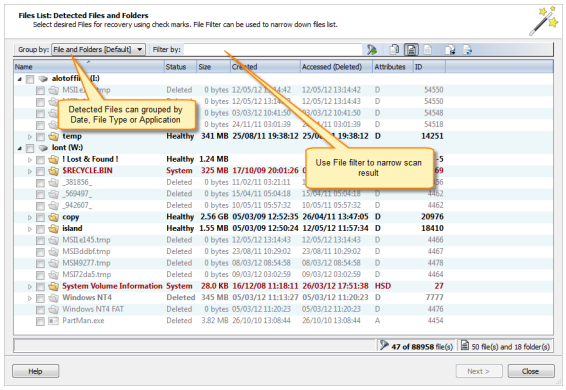
1. Select Logical Drives

   Select at least one logical drive to scan for deleted files.
2. Scan

   Scan selected logical drives for deleted files and folders. The scan can be stopped at any time.

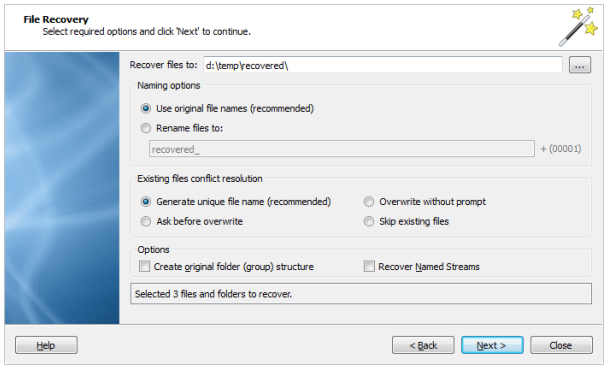
3. Review volume scan results

   Use the *File filter toolbar control* on page 38 to narrow down search results. By default, only deleted **Files and Folders** are shown. To view all files detected on scanned devices, click the **Reset** filter to default button in the toolbar.


Files List: Detected Files and Folders
Select desired Files for recovery using check marks. File Filter can be used to narrow down files list.
Group by: File and Folders [Default]
Filter by:
Detected Files can grouped by Date, File Type or Application
Use File filter to narrow scan result
47 of 88958 file(s)
50 file(s) and 18 folder(s)
Help
Next >
Close

   Select file(s) to recover and click **Next** to continue.

4. Recover Files



Use original file names

Names of detected files will be preserved only if no file with that name exists in the destination directory.

Rename files

All files will be renamed by their given specified file root name and added enumeration ID. The file's extension remains intact.

Unique file name

If a file with the same name exists in the destination folder, files with a unique name will be generated to avoid overwriting.

Ask before overwrite

If a file with a certain name already exists in the destination folder, the application will ask the user what action to take.

Overwrite without prompt

All files will be overwritten in the event they already exist in the destination folder.

Skip existing files

If file with the same name exists in the destination folder, the recovery of a new file will be skipped.

Create Folder Structures

When this option is selected, files will be recovered with their original folder structures e.g. the original folder hierarchy as it was on the source storage device. In case the files were organized in groups (by date, file extensions, or an associated application), then such groupings will be created by the folder structure in the location where the files will be recovered to.

Recover Name Streams

With this option on, files will be recovered with their original named streams.

Verify default recovery options and click **Next** to continue.

5. Confirm Recovery

   Review recovery options, destination path etc. and click **Recover** to start recovering files.

6. Complete wizard

   Click the **Finish** button to complete the Wizard.

After the recovery wizard has completed, you can open the destination folder to which the files were recovered. Use the default OS File Explorer or repeat the wizard again to scan another logical drive.

Note: All scan results will remain available after the wizard closes.

Recover files detected by their signatures wizard

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

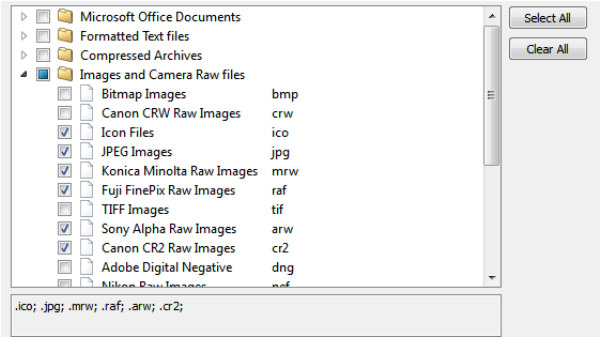
Some files has unique patterns, allowed them to be found by advanced scan process. This Wizard will guide you via simple steps to help you to detect files by File Signature. It will allow you to review and recover detected files. To run this Wizard - click Recover Files by Signature from the Wizards menu, or click Recover Files by Signature button in Tools Tab in Command Bar.

1. Select Logical Drives

   Select at least one Logical Drive to scan for deleted files by File Signatures.

2. Select File Signatures to detect

   Scan selected Logical Drives for deleted files and folders. Scan can be stopped at any time.



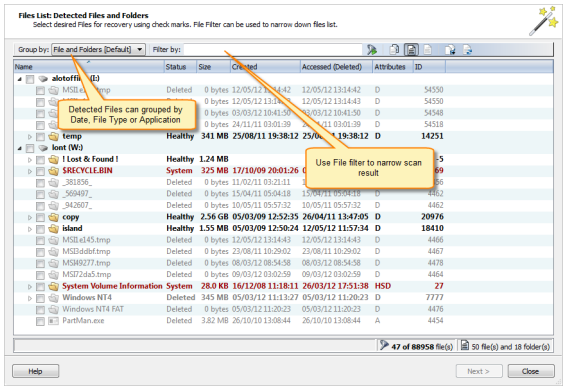
Note: Number of File Signatures impacts the scanning time.

3. Confirm and Scan

   Review scan options and initiate scan process by clicking Scan button. The scan can be stopped at any time.

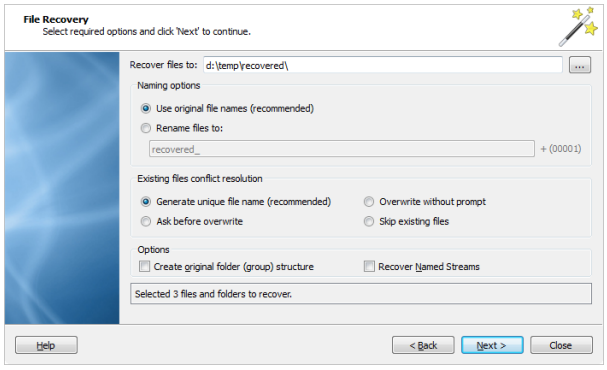
4. Review volume scan results

   Use the *File filter toolbar control* on page 38 to narrow down search results. By default, only deleted **Files and Folders** are shown. To view all files detected on scanned devices, click the **Reset** filter to default button in the toolbar.


Files List: Detected Files and Folders
Select desired Files for recovery using check marks. File Filter can be used to narrow down files list.
Detected Files can grouped by Date, File Type or Application
Use File filter to narrow scan result
Help
Next >
Close

Select file(s) to recover and click **Next** to continue.

5. Recover Files



Use original file names

Names of detected files will be preserved only if no file with that name exists in the destination directory.

Rename files

All files will be renamed by their given specified file root name and added enumeration ID. The file's extension remains intact.

Unique file name

If a file with the same name exists in the destination folder, files with a unique name will be generated to avoid overwriting.

Ask before overwrite

If a file with a certain name already exists in the destination folder, the application will ask the user what action to take.

Overwrite without prompt

All files will be overwritten in the event they already exist in the destination folder.

Skip existing files

If file with the same name exists in the destination folder, the recovery of a new file will be skipped.

Create Folder Structures

When this option is selected, files will be recovered with their original folder structures e.g. the original folder hierarchy as it was on the source storage device. In case the files were organized in groups (by date, file extensions, or an associated application), then such groupings will be created by the folder structure in the location where the files will be recovered to.

Recover Name Streams

With this option on, files will be recovered with their original named streams.

Verify default recovery options and click **Next** to continue.

6. Confirm Recovery

Review recovery options, destination path etc. and click **Recover** to start recovering files.

7. Complete wizard

   Click the **Finish** button to complete the Wizard.

After the recovery wizard has completed, you can open the destination folder to which the files were recovered. Use the default OS File Explorer or repeat the wizard again to scan another logical drive.

Note: All scan results will remain available after the wizard closes.

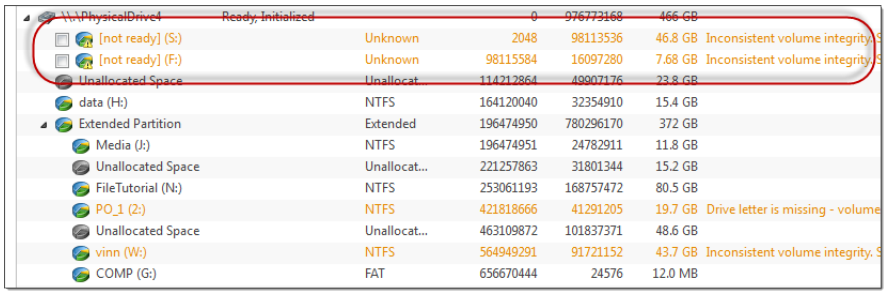
Recover files from a damaged partition wizard

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

The **Recover Files from a Damaged Partition Wizard** allow to recover files by their signatures from damaged (corrupted) partition those which in most cases are inaccessible by operating system.

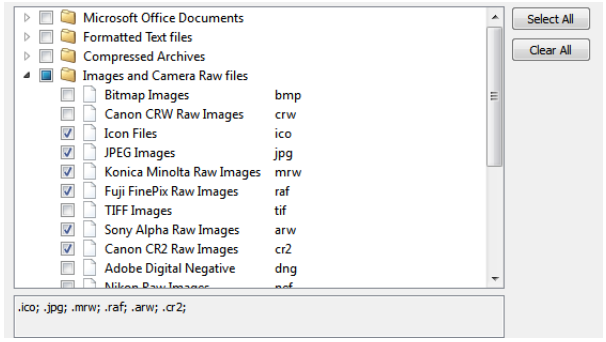
1. Scan damaged partitions

   Select at least one damaged partition (volume) to scan missing files.


\\.\PhysicalDrive4 Ready, Initialized 0 976773168 466 GB
[not ready] (S:) Unknown 2048 98113536 46.8 GB Inconsistent volume integrity
[not ready] (F:) Unknown 98115584 16097280 7.68 GB Inconsistent volume integrity
Unallocated Space Unallocat... 114212864 49907176 23.8 GB
data (H:) NTFS 164120040 32354910 15.4 GB
Extended Partition Extended 196474950 780296170 372 GB
Media (J:) NTFS 196474951 24782911 11.8 GB
Unallocated Space Unallocat... 221257863 31801344 15.2 GB
FileTutorial (N:) NTFS 253061193 168757472 80.5 GB
PO_1 (2:) NTFS 421818666 41291205 19.7 GB Drive letter is missing - volume
Unallocated Space Unallocat... 463109872 101837371 48.6 GB
vinn (W:) NTFS 564949291 91721152 43.7 GB Inconsistent volume integrity
COMP (G:) FAT 656670444 24576 12.0 MB

2. Select File Signatures to detect

   Scan selected Logical Drives for deleted files and folders. Scan can be stopped at any time.



Note: Number of File Signatures impacts the scanning time.

3. Confirm and Scan

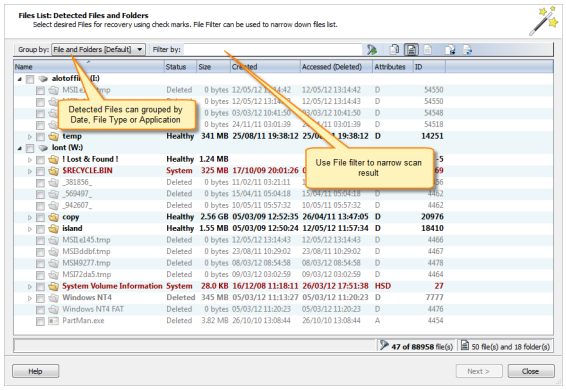
   Review scan options and initiate scan process by clicking Scan button. The scan can be stopped at any time.

4. Scan

   Scan selected logical drives for deleted files and folders. The scan can be stopped at any time.

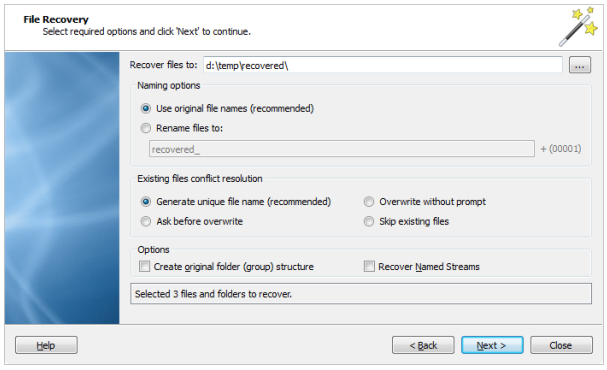
5. Review volume scan results

   Use the *File filter toolbar control* on page 38 to narrow down search results. By default, only deleted **Files and Folders** are shown. To view all files detected on scanned devices, click the **Reset** filter to default button in the toolbar.


Files List: Detected Files and Folders
Select desired Files for recovery using check marks. File Filter can be used to narrow down files list.
Detected Files can grouped by Date, File Type or Application
Use File filter to narrow scan result
Help
Next >
Close

Select file(s) to recover and click **Next** to continue.

6. Recover Files



Use original file names

Names of detected files will be preserved only if no file with that name exists in the destination directory.

Rename files

All files will be renamed by their given specified file root name and added enumeration ID. The file's extension remains intact.

Unique file name

If a file with the same name exists in the destination folder, files with a unique name will be generated to avoid overwriting.

Ask before overwrite

If a file with a certain name already exists in the destination folder, the application will ask the user what action to take.

Overwrite without prompt

All files will be overwritten in the event they already exist in the destination folder.

Skip existing files

If file with the same name exists in the destination folder, the recovery of a new file will be skipped.

Create Folder Structures

When this option is selected, files will be recovered with their original folder structures e.g. the original folder hierarchy as it was on the source storage device. In case the files were organized in groups (by date, file extensions, or an associated application), then such groupings will be created by the folder structure in the location where the files will be recovered to.

Recover Name Streams

With this option on, files will be recovered with their original named streams.

Verify default recovery options and click **Next** to continue.

7. Confirm Recovery

Review recovery options, destination path etc. and click **Recover** to start recovering files.

8. Complete wizard

   Click the **Finish** button to complete the Wizard.

After the recovery wizard has completed, you can open the destination folder to which the files were recovered. Use the default OS File Explorer or repeat the wizard again to scan another logical drive.

Note: All scan results will remain available after the wizard closes.

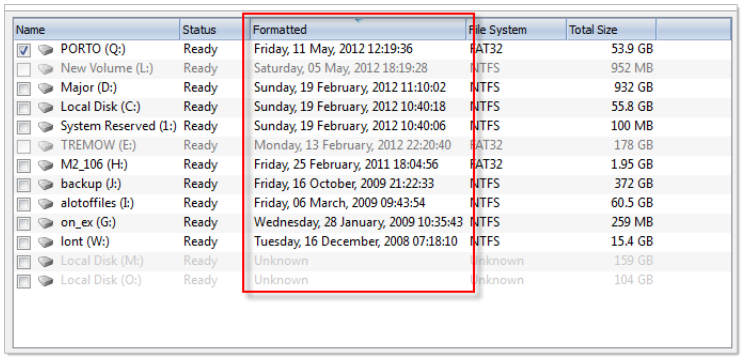
Recover files from a formatted partition wizard

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Some files have unique patterns, allowed them to be found by an advanced scan process. This wizard will guide you via simple steps to help you to detect files by their file signature. It will allow you to review and recover detected files. To run this wizard click Recover Files by Signature from the wizards menu, or click the Recover Files by Signature button in the Tools tab in the command bar.

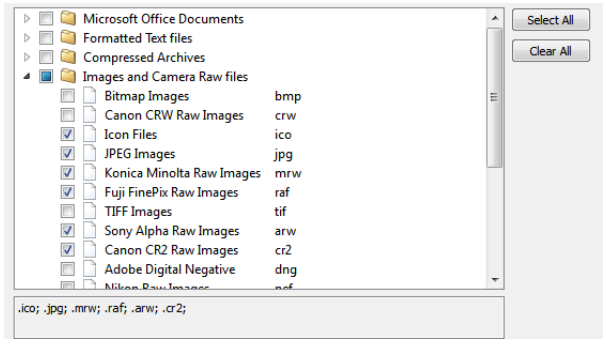
1. Select formatted volumes

   Select at least one logical drive to scan from the list of available logical drives sorted by formatted date. The most recently formatted drive will be selected automatically.


Name
Status
Formatted
File System
Total Size
PORTO (Q:) Ready Friday, 11 May, 2012 12:19:36 FAT32 53.9 GB
New Volume (L:) Ready Saturday, 05 May, 2012 18:19:28 NTFS 952 MB
Major (D:) Ready Sunday, 19 February, 2012 11:10:02 NTFS 932 GB
Local Disk (C:) Ready Sunday, 19 February, 2012 10:40:18 NTFS 55.8 GB
System Reserved (1:) Ready Sunday, 19 February, 2012 10:40:06 NTFS 100 MB
TREMOW (E:) Ready Monday, 13 February, 2012 22:20:40 FAT32 178 GB
M2_106 (H:) Ready Friday, 25 February, 2011 18:04:56 FAT32 1.95 GB
backup (J:) Ready Friday, 16 October, 2009 21:22:33 NTFS 372 GB
alotoffiles (I:) Ready Friday, 06 March, 2009 09:43:54 NTFS 60.5 GB
on_ex (G:) Ready Wednesday, 28 January, 2009 10:35:43 NTFS 259 MB
Iont (W:) Ready Tuesday, 16 December, 2008 07:18:10 NTFS 15.4 GB
Local Disk (M:) Ready Unknown Unknown 159 GB
Local Disk (O:) Ready Unknown Unknown 104 GB

2. Select File Signatures to detect

   Scan selected Logical Drives for deleted files and folders. Scan can be stopped at any time.



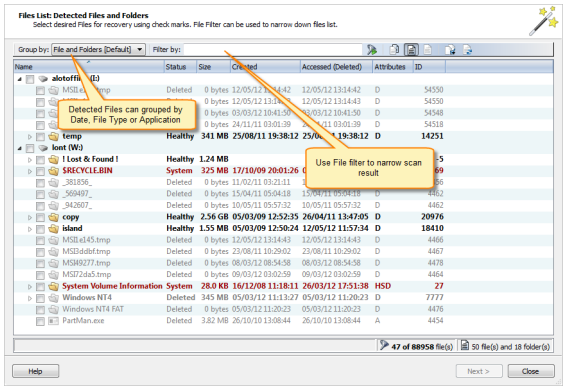
Note: Number of File Signatures impacts the scanning time.

3. Confirm and Scan

   Review scan options and initiate scan process by clicking Scan button. The scan can be stopped at any time.

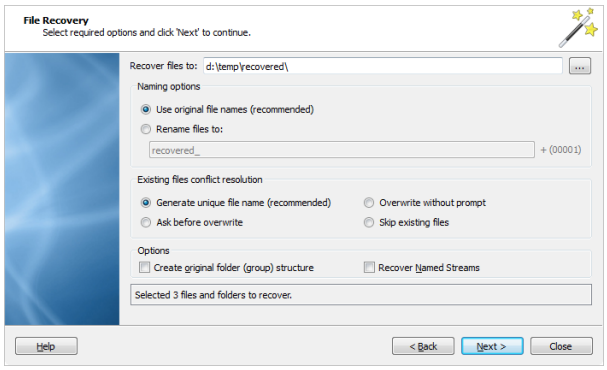
4. Review volume scan results

Use the *File filter toolbar control* on page 38 to narrow down search results. By default, only deleted **Files and Folders** are shown. To view all files detected on scanned devices, click the **Reset** filter to default button in the toolbar.


Files List: Detected Files and Folders
Select desired Files for recovery using check marks. File Filter can be used to narrow down files list.
Detected Files can grouped by Date, File Type or Application
Use File filter to narrow scan result
Help
Next >
Close

Select file(s) to recover and click **Next** to continue.

5. Recover Files



Use original file names

Names of detected files will be preserved only if no file with that name exists in the destination directory.

Rename files

All files will be renamed by their given specified file root name and added enumeration ID. The file's extension remains intact.

Unique file name

If a file with the same name exists in the destination folder, files with a unique name will be generated to avoid overwriting.

Ask before overwrite

If a file with a certain name already exists in the destination folder, the application will ask the user what action to take.

Overwrite without prompt

All files will be overwritten in the event they already exist in the destination folder.

Skip existing files

If file with the same name exists in the destination folder, the recovery of a new file will be skipped.

Create Folder Structures

When this option is selected, files will be recovered with their original folder structures e.g. the original folder hierarchy as it was on the source storage device. In case the files were organized in groups (by date, file extensions, or an associated application), then such groupings will be created by the folder structure in the location where the files will be recovered to.

Recover Name Streams

With this option on, files will be recovered with their original named streams.

Verify default recovery options and click **Next** to continue.

6. Confirm Recovery

   Review recovery options, destination path etc. and click **Recover** to start recovering files.

7. Complete wizard

   Click the **Finish** button to complete the Wizard.

After the recovery wizard has completed, you can open the destination folder to which the files were recovered. Use the default OS File Explorer or repeat the wizard again to scan another logical drive.

Note: All scan results will remain available after the wizard closes.

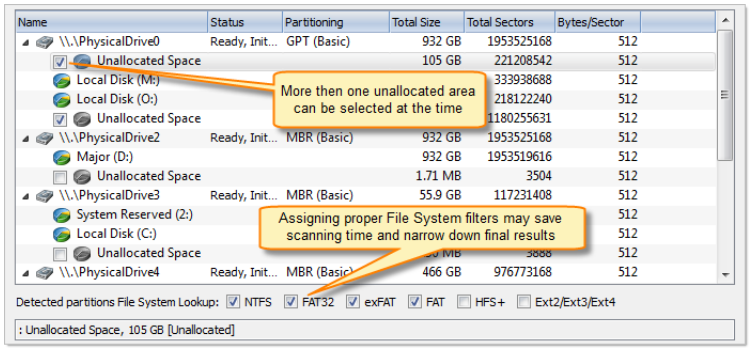
Recover files from a deleted partitions wizard

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

In this wizard, unallocated spaces on data storage devices are scanned for deleted partitions. After partitions are detected, they should be scanned for files and folders.

1. Scan unallocated space

   Select unallocated area by placing check marks in the data storage devices tree and click **Next** to continue.



File system lookup

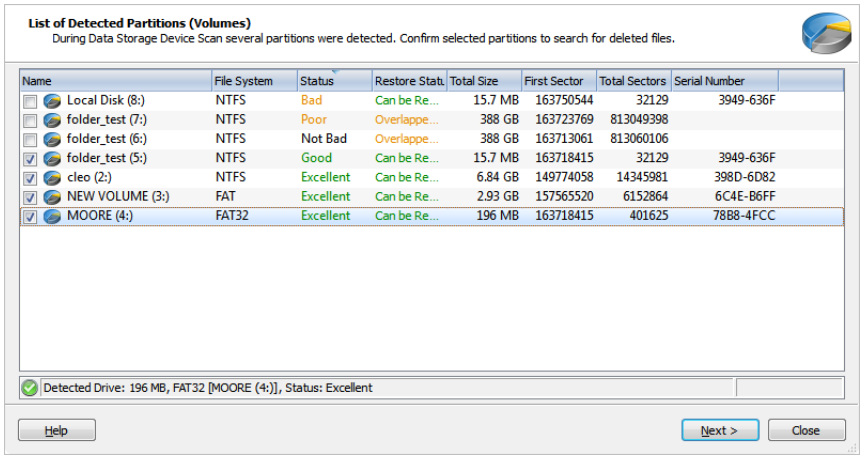
Select File System of a partitions to be detected

2. Confirm and scan for deleted partitions

   Review and confirm the unallocated space scan parameters and click the Scan button to start the scanning process. While the process is in progress, you can cancel it at any time by clicking Stop at the bottom of the screen.

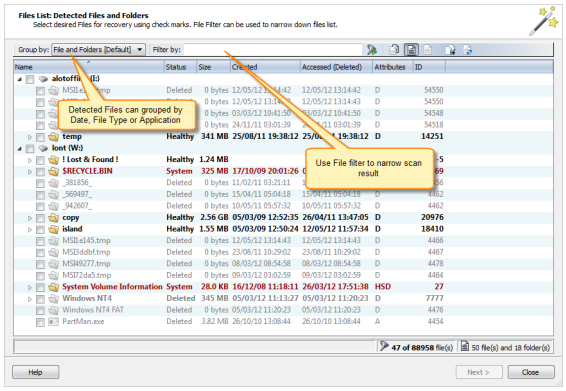
3. Scan detected partitions

   Review list of detected partitions and select at least one of them to scan for missing files.



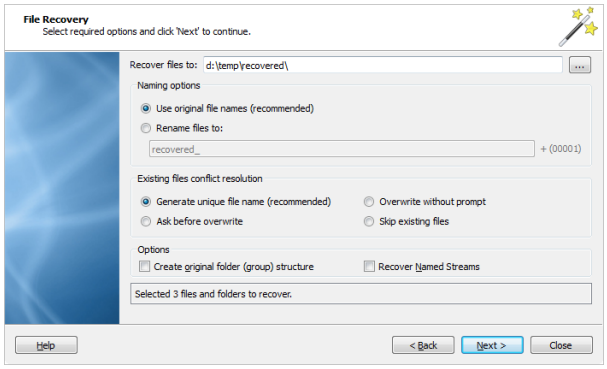
4. Review volume scan results

   Use the *File filter toolbar control* on page 38 to narrow down search results. By default, only deleted **Files and Folders** are shown. To view all files detected on scanned devices, click the **Reset** filter to default button in the toolbar.


Files List: Detected Files and Folders
Select desired Files for recovery using check marks. File Filter can be used to narrow down files list.
Detected Files can grouped by Date, File Type or Application
Use File filter to narrow scan result
Help
Next >
Close

   Select file(s) to recover and click **Next** to continue.

5. Recover Files



Use original file names

Names of detected files will be preserved only if no file with that name exists in the destination directory.

Rename files

All files will be renamed by their given specified file root name and added enumeration ID. The file's extension remains intact.

Unique file name

If a file with the same name exists in the destination folder, files with a unique name will be generated to avoid overwriting.

Ask before overwrite

If a file with a certain name already exists in the destination folder, the application will ask the user what action to take.

Overwrite without prompt

All files will be overwritten in the event they already exist in the destination folder.

Skip existing files

If file with the same name exists in the destination folder, the recovery of a new file will be skipped.

Create Folder Structures

When this option is selected, files will be recovered with their original folder structures e.g. the original folder hierarchy as it was on the source storage device. In case the files were organized in groups (by date, file extensions, or an associated application), then such groupings will be created by the folder structure in the location where the files will be recovered to.

Recover Name Streams

With this option on, files will be recovered with their original named streams.

Verify default recovery options and click **Next** to continue.

6. Confirm Recovery

   Review recovery options, destination path etc. and click **Recover** to start recovering files.

7. Complete wizard

   Click the **Finish** button to complete the Wizard.

After the recovery wizard has completed, you can open the destination folder to which the files were recovered. Use the default OS File Explorer or repeat the wizard again to scan another logical drive.

Note: All scan results will remain available after the wizard closes.

Recover files from a physical disk wizard

Active @ UNDELETE file recovery wizards [draft]

This wizard is a universal guided tool that allows the recovery of files from detected partitions or data storage devices where files are detected by file signatures.

Disk image wizards

Create a disk image wizard

Active UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

This wizard guides you through simple steps to create a Disk Image of a data storage device or a logical drive.

A Disk Image is a single file or a series of files that stores all the data from your logical drive or physical device as a mirror image. Having a Disk Image can be useful when you want to back up the contents of the whole drive, and restore it or work with it later.

When the Create Disk Image Wizard starts for the first time, the first screen describes the process. Clear the **Show this dialog next time?** check box to avoid seeing this screen the next time you create a Disk Image.

To start the Create Disk Image Wizard, do one of the following:

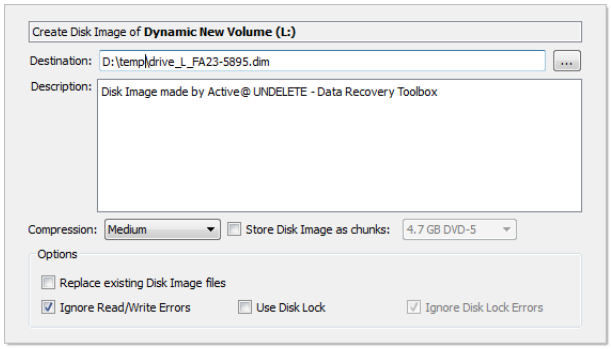
- From the **Wizards** menu, click **Create Disk Image**
- Select **Disk Image** tab in the Command Bar and click **Create Disk Image**

1. Select imaging area

   Select a data storage device in the hierarchical device/partition tree and select the desired device area if necessary.

   Note: By clicking on a partition item in the device map, control of the entire partition area will be selected.

2. Set Disk Image attributes



   Destination Path

   The full path for the single Disk Image file. If you decide to store the Disk Image file in chunks, this path will be used to store all files. You have the option to use the default path, enter a new path or click **Browse** and navigate to the folder that will store the Disk Image.

   Description

   Enter a detailed description of the Disk Image you are about to create.

   Compression

   Choose one of the following:

   - **None [Raw Data]** - No compression is applied, sectors are stored in raw format.
   - **Fast** - Sectors are compressed before storing to the file using a fast compression algorithm.
   - **Medium** - Sectors are compressed before storing to the file using a slow but more effective compression algorithm.
   - **High** - High level of compression;
   - **Highest** - Highest possible compression level ill be used;

   Store Disk Image as chunks:

   Select this check box to save the Disk Image as a series of files with a specified size. Choose the file size from the drop-down list. This option may be useful if you want to write the Disk Image to CD-ROMs or DVD-ROMs. By default this check box is cleared and the Disk Image is stored in one large file;

   Ignore R/W Errors

   Any Read or Write errors will be ignored and process will continue if possible;

   Use Disk Lock

   Source disk will be locked until Disk Image creation is complete or aborted;

   Ignore Disk Lock Errors

   Any errors related to disk lock will be ignored;

3. Confirm actions

   Review and confirm the disk image parameters and click the Create Disk Image button to start the disk image creation process. While the process is in progress, you can stop it at any time by clicking Stop at the bottom of the screen.

4. Complete

   Click Finish to close the wizard when the disk image creation is complete.

You can work with a disk image in the same way as you work with a regular storage device or logical drive. You can:

- Scan it as a device for deleted or damaged partitions.
- Scan logical drives and search for files.
- Recover or copy files and folders to another safe location.

Open a disk image wizard

Active UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

This Wizard will guide you via simple steps to open a *Disk Image* that was previously created. You can open a Disk Image based on a configuration file or compose a Disk Image from raw chunks. These chunks may be created by third party software. After a Disk Image is opened you are able to work with it as you would work with a regular Logical Drive or Data Storage Device. You can scan an opened Disk Image, view its contents, and recover files and folders from the Disk Image.

To start the Open Disk Image Wizard - run the **Open Disk Image** menu command from the **Wizards** menu, or click the **Open Disk Image** button on the **Disk Image Tab** Command Bar on the left side.

1. Open Disk Image configuration file

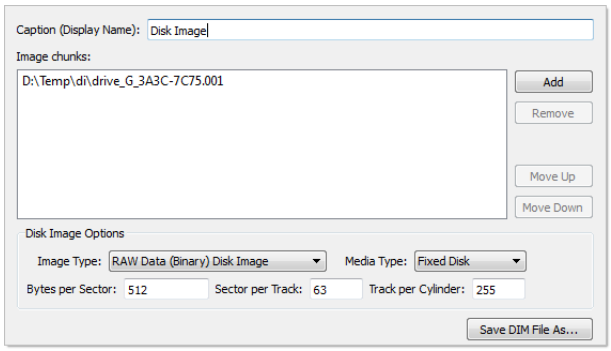
   A *Disk Image Configuration File* is a file, used to store all information about a created Disk Image including disk geometry and annotation labels. A Disk Image configuration File is created during the Create Disk Image procedure. You can select a Disk Image to be opened by specifying its Disk Image Configuration File. Type the full path to this file in the edit box or use the **Browse** button to open a standard browse dialog to select this file.

   You can skip this step in order to assemble a Disk Image manually from chunks supplying all necessary options yourself by clicking **Next** button

2. Compose Disk Image

   Skip this step if disk image was opened using a configuration file (information is already entered), otherwise specify all parameters here manually.

   Typically, a Disk Image Configuration File is used to open a Disk Image. This file contains necessary information about the Disk Image geometry, labels and other information. Nevertheless, a Disk Image can be open by specifying actual files (chunks) of an image and other options. This dialog can be also used to open raw Disk Images created by third party applications (such as WinHex for example)



Caption

Enter any label to distinguish newly opened disk image among other devices and disks.

Disk Image Chunks

A Disk Image consists of one or many files, which contains actual image data. A Disk Image can be cut into several files (chunks) during creation for better space allocation. In this list you have to specify all these files which make ups the image. To Add a Disk Image chunk to the list click the **Add New** button and use browse for a file dialog to select a file. To Remove a Disk Image chunk, select this chunk in the list and click the **Remove** button. To modify the order of Disk Image chunks, select any chunk you wish to relocate and use the **Up** and **Down** buttons to move a selected chunk in the chunk stack.

Image Type

Select image type you about to open. Usually it assigned automatically, depending on Disk Image chunks added.

- **Raw Disk Image** - Raw fragment of a disk;
- **LSoft Disk Image** - Disk Image created by any LSoft Technology product;
- **Virtual PC** - Disk Images from Virtual PC software;
- **VM Ware Image** - Disk Images from VM Ware software;

Media Type

Select appropriate media type. Usually it assign automatically. Use **Fixed Disk** by default.

Bytes per Sector

Enter sector size in bytes;

Sectors per Track

Enter track size in sectors;

Tracks per Cylinder

Enter cylinder size in tracks;

Save DIM File as...

In case of manual composition of Disk Image properties you may save final configuration file for later use;

Click **Next** to continue.

3. Confirmation

   Verify and confirm parameters for the disk image to be opened.

   Click **Open Disk Image** to read the Disk Image structure and open the Disk Image.

4. Complete

   Click **Finish** to close the Wizard.

   A new storage device and one or several drives (if detected) will appear in the list of devices and drives in the **Recovery Explorer.**

   You can work with an opened Disk Image the same way as you work with a regular storage device or logical drive, i.e. scan device for deleted/damaged partitions, scan drives and search for files, recover/copy files and folders to another safe location, etc..

Verify a disk image wizard

Active UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Disk image validation insures that a data storage disk image or a logical drive disk image is consistent internally and can be opened. We advise you to use this wizard to validate disk images created by third party applications.

1. Start wizard

   - Run the **Verify Disk Image** menu command from the **Tools** menu
   - or click the **Validate Disk Image** button on the disk image tab in the command bar on the left side.

   When the Restore Partition wizard starts for the first time, the first screen describes the process. Clear the "*Show this page next time?*" check box to avoid seeing this screen the next time you run this wizard.

2. Open Disk Image configuration file

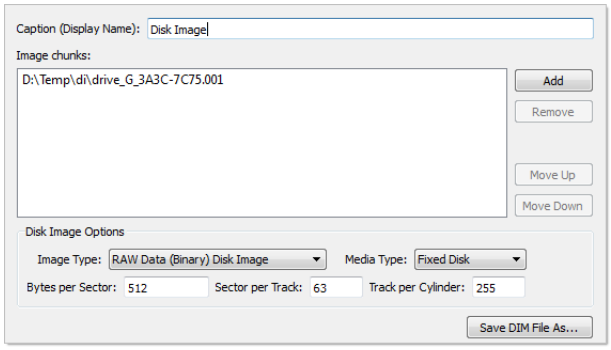
   A Disk Image configuration File is a file, used to store all information about a created Disk Image including disk geometry and annotation labels. A Disk Image configuration File is created during the Create Disk Image procedure. You can select a Disk Image to be opened by specifying its Disk Image Configuration File. Type in the full path to this file in the edit box or use the browse button to open a 'Browse for file" dialog and to select this file.

You can skip this step in order to assemble a Disk Image manually from chunks supplying all necessary options yourself.

3. Compose Disk Image

Skip this step if disk image was opened using a configuration file (information is already entered), otherwise specify all parameters here manually.

Typically, a Disk Image Configuration File is used to open a Disk Image. This file contains necessary information about the Disk Image geometry, labels and other information. Nevertheless, a Disk Image can be open by specifying actual files (chunks) of an image and other options. This dialog can be also used to open raw Disk Images created by third party applications (such as WinHex for example)



Caption

Enter any label to distinguish newly opened disk image among other devices and disks.

Disk Image Chunks

A Disk Image consists of one or many files, which contains actual image data. A Disk Image can be cut into several files (chunks) during creation for better space allocation. In this list you have to specify all these files which make ups the image. To Add a Disk Image chunk to the list click the **Add New** button and use browse for a file dialog to select a file. To Remove a Disk Image chunk, select this chunk in the list and click the **Remove** button. To modify the order of Disk Image chunks, select any chunk you wish to relocate and use the **Up** and **Down** buttons to move a selected chunk in the chunk stack.

Image Type

Select image type you about to open. Usually it assigned automatically, depending on Disk Image chunks added.

- **Raw Disk Image** - Raw fragment of a disk;
- **LSoft Disk Image** - Disk Image created by any LSoft Technology product;
- **Virtual PC** - Disk Images from Virtual PC software;
- **VM Ware Image** - Disk Images from VM Ware software;

Media Type

Select appropriate media type. Usually it assign automatically. Use **Fixed Disk** by default.

Bytes per Sector

Enter sector size in bytes;

Sectors per Track

Enter track size in sectors;

Tracks per Cylinder

Enter cylinder size in tracks;

Save DIM File as...

In case of manual composition of Disk Image properties you may save final configuration file for later use;

Click **Next** to continue.

4. Confirmation

Verify and confirm parameters for the disk image to be opened.

Click **Verify Disk Image** to read the Disk Image structure and initiaite verification process.

5. Complete

When verification is completed you will see verification report indicating current integrity of your Disk Image.

Click **Finish** to close the Wizard.

Partition management wizards

Restore a deleted partition wizard

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

This wizard guides you through simple steps to help you to detect and restore deleted or damaged partitions. The Restore Partition wizard guides you through three processes:

1. Detecting deleted or damaged partitions.
2. Analyzing the content of a detected partition and optionally modifying its geometry.
3. Restoring the partition.

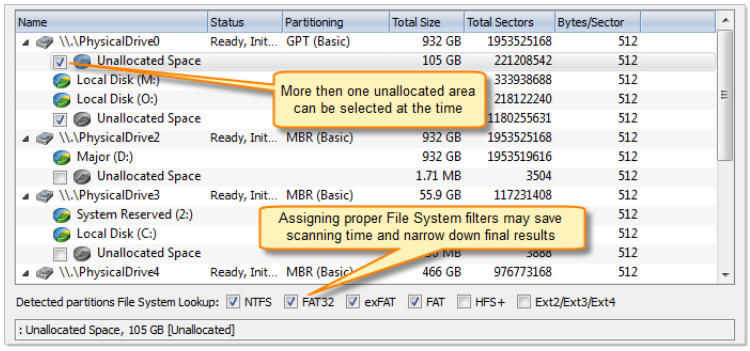
1. Start Restore Partition wizard

- From the **Wizards** menu, click **Restore Deleted Partitions** command.
- Select the **Partition Management** tab in the command bar and click **Restore Deleted Partitions**.

When the Restore Partition wizard starts for the first time, the first screen describes the process. Clear the “Show this page next time?” check box to avoid seeing this screen the next time you run this wizard.

2. Scan unallocated space

Select unallocated area by placing check marks in the data storage devices tree and click **Next** to continue.


Name
Status
Partitioning
Total Size
Total Sectors
Bytes/Sector
\\.\PhysicalDrive0 Ready, Init... GPT (Basic) 932 GB 1953525168 512
Unallocated Space 105 GB 221208542 512
Local Disk (M:) 333938688 512
Local Disk (O:) 218122240 512
Unallocated Space 1180255631 512
\\.\PhysicalDrive2 Ready, Init... MBR (Basic) 932 GB 1953525168 512
Major (D:) 932 GB 1953519616 512
Unallocated Space 1.71 MB 3504 512
\\.\PhysicalDrive3 Ready, Init... MBR (Basic) 55.9 GB 117231408 512
System Reserved (2:) 512
Local Disk (C:) 512
Unallocated Space 512
\\.\PhysicalDrive4 Ready, Init... MBR (Basic) 466 GB 976773168 512
More then one unallocated area can be selected at the time
Assigning proper File System filters may save scanning time and narrow down final results
Detected partitions File System Lookup: NTFS FAT32 exFAT FAT HFS+ Ext2/Ext3/Ext4
: Unallocated Space, 105 GB [Unallocated]

File system lookup

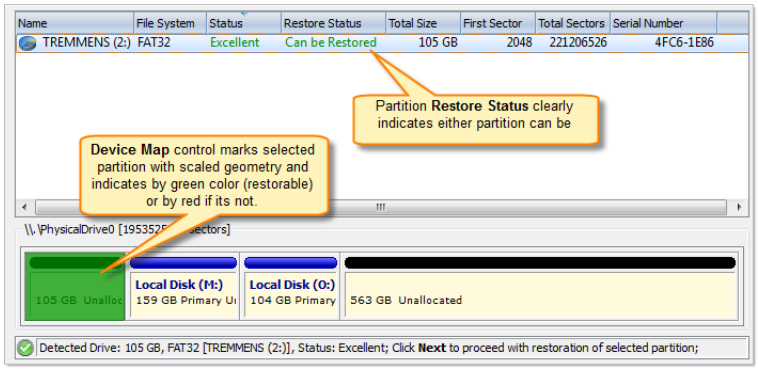
Select File System of a partitions to be detected

3. Confirm and scan for deleted partitions

Review and confirm the unallocated space scan parameters and click the **Scan** button to start the scanning process. While the process is in progress, you can cancel it at any time by clicking **Stop** button at the bottom of the screen.

4. Review scan results

Select the partition to restore from the list of detected partitions and, if partition can be restored, click the **Next** button to continue.



5. Confirm Partition Recovery

   Review and confirm the partition recovery and click the **Restore** button to restore the selected partition. If the action is successful, the restored partition will appear in the data storage device area of the **Recovery Explorer**.

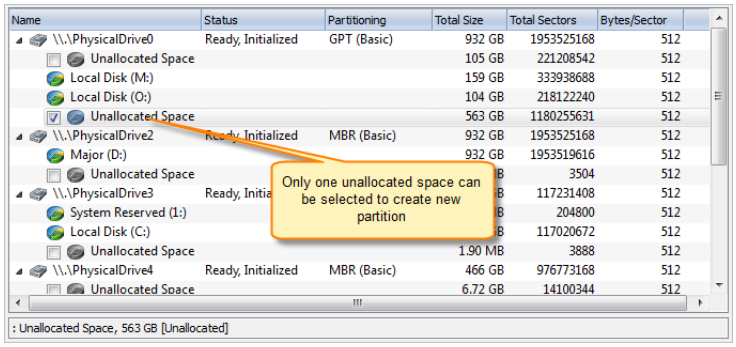
Create a new partition wizard

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

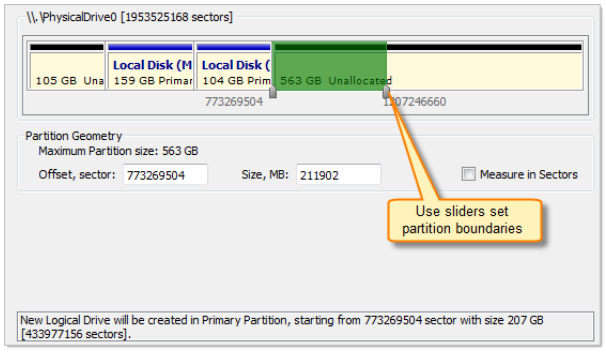
This wizard guides you through simple steps to help you to create a new partition on a data storage device. When the **Restore Partition** wizard starts for the first time, the first screen describes the process. Clear the **Show this page next time?** check box to avoid seeing this screen the next time you run this wizard.

1. Select Unallocated Space

   Select the unallocated space where the new partition must be created and click the Next button to continue.



2. Select partition geometry (attributes)


\\.\PhysicalDrive0 [1953525168 sectors]
105 GB Una
159 GB Primar
104 GB Prim
563 GB Unallocated
773269504
1207246660
Partition Geometry
Maximum Partition size: 563 GB
Offset, sector: 773269504
Size, MB: 211902
Measure in Sectors
Use sliders set partition boundaries
New Logical Drive will be created in Primary Partition, starting from 773269504 sector with size 207 GB [433977156 sectors].

Offset

First sector of created partition. It can be set exact by numerical value entered in text box or by moving left slider in Device Map control;

Size

Partition size can be set in megabytes or in sectors, depending on state of **Measure in Sectors** check box;

Measure in sectors

Set this option on, to use sectors instead of megabytes as partition measurements;

3. Partition Attributes

Mark Partition as Active

Newly created partition will be set as Active Partition

Assign Drive letter

For Primary Partition or Logical Drive on extended partition drive letter can be assigned from the list of available in the system drive letters

4. Format Partition

This step is optional. Click set so **Do not format new partition** and click **Next** button to continue.

Volume Label

Enter distinctive volume label;

File System

Select on of the file system supported;

Allocation unit size

Allocation unit size depends on *File System* selected. Leave *Default* for mots of the cases;

5. Confirm Actions

Review and confirm new partition attributes and click **Create Partition** button to initiate creation process.

6. Complete

Click **Finish** to close the Wizard.

If wizard was successful, a new partition will appear under corresponded *disk* item in **Recovery Explorer**.

Create a virtual RAID wizard

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

This Wizard will guide you via simple steps to help you to re-assemble a damaged or disassembled RAID set to create a *Virtual Disk Array*. It will allow you to review and recover data located on the RAID set.

- To create a Virtual Disk Array you must specify the type of disk array (RAID type), disks and array geometry.
- You can manipulate the number and order of disks in the array.
- You can specify your own Virtual Disk Array geometry or accept the default values.

1. Run Create Virtual Array wizard

   - click **Create Virtual Array** from the **Wizards** menu,
   - or click **Create Virtual RAID** button in **Tools** tab in Command Bar.

2. Select Array Type

Select a RAID type to be reconstructed:

Spanned Volume

Composed of disk space located on several disks consecutively.

Stripe Set (RAID0)

Stores data in stripes distributed on two or more disks.

Mirror (RAID1)

Duplicates data identically on two disks.

RAID5

Stores data in stripes distributed on three or more disks with parity control.

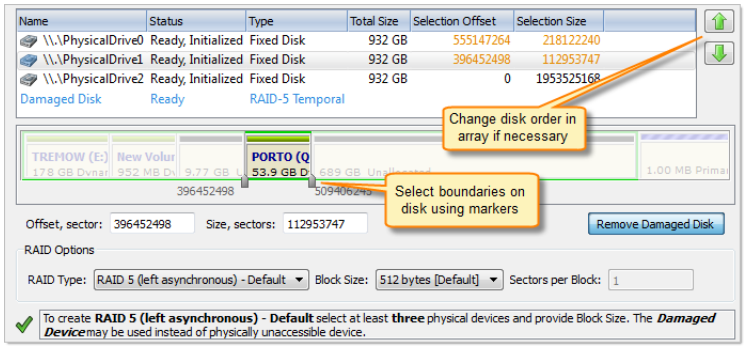
3. Select Array Disks

Choose disks to compose a Virtual Disk Array.

Use the **[Damaged Disk]** virtual device instead of the disk that is physically damaged (e.g. a non spinning disk), or is known to contains invalid information. Some RAIDs types (Mirror, RAID5) allow you to recover information even if one of the disks is lost this way.

4. Disk Options

Choose default geometry options or specify custom values.


Name
Status
Type
Total Size
Selection Offset
Selection Size
\\.\PhysicalDrive0 Ready, Initialized Fixed Disk 932 GB 555147264 218122240
\\.\PhysicalDrive1 Ready, Initialized Fixed Disk 932 GB 396452498 112953747
\\.\PhysicalDrive2 Ready, Initialized Fixed Disk 932 GB 0 1953525168
Damaged Disk Ready RAID-5 Temporal
Change disk order in array if necessary
TREMOW (E:)
New Volur
PORTO (Q
53.9 GB D
1.00 MB Primar
396452498
Select boundaries on disk using markers
Offset, sector: 396452498
Size, sectors: 112953747
Remove Damaged Disk
RAID Options
RAID Type: RAID 5 (left asynchronous) - Default
Block Size: 512 bytes [Default]
Sectors per Block: 1
To create RAID 5 (left asynchronous) - Default select at least three physical devices and provide Block Size. The Damaged Device may be used instead of physically unaccessible device.

Offset

Address of selected area on current disk;

Size, sectors

Size of selected area on current disk;

Number of Tracks per Cylinder

Number of tracks in each cylinder on all platters making up a hard disk. For example, if a hard disk has four platters, each with 600 tracks, then there will be 600 cylinders, and each cylinder will consist of 8 tracks (assuming that each platter has tracks on both sides).

Number of Sectors per Track

A Sector is the smallest unit that can be accessed on a disk. The tracks are concentric circles around the disk and the sectors are segments within each circle. This value indicates how many sectors are on each track.

Stripe Block size

The Size of a block in kilobytes used for RAID creation. Applicable to RAID-0 and RAID-5 arrays. Standard values are 32Kb, 64Kb, 128Kb, 256Kb. If you are not sure - try all standard sizes consecutively and you will most likely find the proper one.

Arrange disks in the Virtual Disk Array using the **Up** and **Down** buttons. If you do not know the particular disk order, try all possible configurations: write down the current order, assemble the array and check the data in it. If the data is not accessible - try a different order until one works.

Some RAID types (Span, RAID5) require a certain stripe block size, thus you will need to specify it in Options box. If you are not sure of this value, you may try to find it in the Controller's configuration utility (Controller's BIOS), or you can try different block sizes and check the results. The most commonly used values are: 32kb, 64kb, 128kb.

5. Confirmation

Review and confirm parameters for the Virtual Disk Array to be created

Click the Create button to create the Virtual Disk Array.

6. Complete

Click the **Finish** button to complete the Wizard.

If the RAID was reconstructed successfully, otherwise you will see error messages.

A new virtual data storage device and one or several drives (if detected) will appear in the list of devices and drives in the **Recovery Explorer**.

You can work with reconstructed RAID sets the same way as you work with a regular storage device or logical drive, i.e. scan device for deleted/damaged partitions, scan drives and search for files, recover/copy files and folders to another safe location, etc...

Advanced tools

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Major `Active@ UNDELETE` tools are:

Disk Editor

Advanced tool for viewing and low-level editing raw data of *physical disks*, *partitions* and *volumes*, contents of any *file* type and *file records*.

Partition Manager **on page 107**

Explore and edit disk partitioning, including create, format and delete partitions, edit disk entries and more.

File Organizer

Organize files collected from different sources in groups before recovery.

Forensic Report **on page 122**

Investigate recent user's activity related to modified or deleted files.

Disk Editor

Overview

`Active@ Disk Editor` is advanced tool for viewing and editing raw data of *physical disks*, *partitions* and *volumes*, contents of any *file* type and *file records*. Disk Editor uses a simple, low-level disk viewer which displays information in binary and text modes at the same time. You can use this view to analyze the contents of data storage structure elements such as:

- Hard disk drives (disks);
- Partitions;
- Volumes (Logical drives);
- File records on volume;
- Files;

Warning: As with any advanced tool, use extreme caution with the `Disk Editor`. Changes that you make may affect disk structure integrity. You must be certain that the changes you make are in line with correct data structures before you save changes.

Disk Editor Preferences

Disk Editor memorize its state and when closed those settings are preserved. The settings saved are view options and geometry of windows.

Read *Application preferences* on page 130 for detailed information.

Saving Changes

Unless stated otherwise, all modifications made in the Disk Editor are stored in memory. Changes are written to the drive when you click **Save**. Read *Working with editor* on page 88 article for more information.

Opening disks, volumes (logical drives) and files with Disk Editor

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

You can open a physical disk, a logical drive, or a partition from the *Recovery Explorer view* on page 8. If you performed scanning, you can also open a file from the list of found files.

In **Disk Editor** you can view and edit following disk objects:

- Physical Disk
- Volume (Logical Drive)
- Partition
- File

To open an object, do one of the following:

- Select an object in a list of disk objects. You may select a physical drive, a partition, or a logical drive. If you performed scanning before, you can also select a file.
- Click the **Open in Disk Editor** button in a toolbar.
- Alternatively, right click on a disk object and select **Open in Disk Editor** from a context menu. You can also use the **Ctrl+H** shortcut.
- In *Welcome view* on page 10 select tab **Advanced Tools** and then click **Open Disk** command. In appeared dialog select physical disk, volume or unallocated space item and click **OK** to open selected in **Disk Editor**.

In **Open in Disk Editor** dialog use filter to adjust disk object list, select an item an click **Open** to continue.

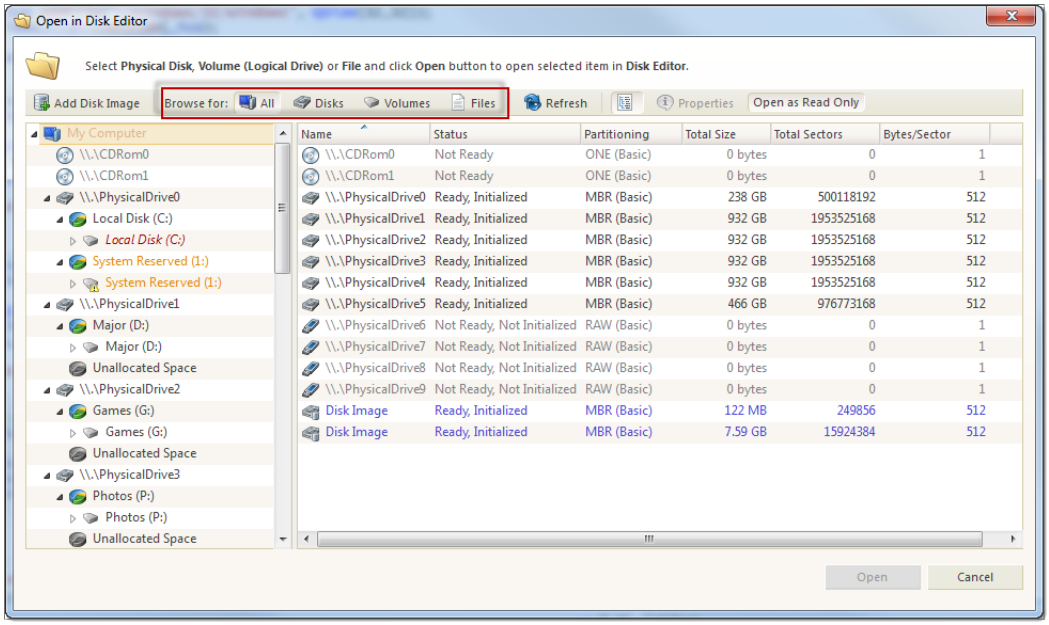

Open in Disk Editor
Select Physical Disk, Volume (Logical Drive) or File and click Open button to open selected item in Disk Editor.
Add Disk Image
Browse for:
All
Disks
Volumes
Files
Refresh
Properties
Open as Read Only
My Computer
\\.\CDRom0
\\.\CDRom1
\\.\PhysicalDrive0
Local Disk (C:)
Local Disk (C:)
System Reserved (1:)
System Reserved (1:)
\\.\PhysicalDrive1
Major (D:)
Major (D:)
Unallocated Space
\\.\PhysicalDrive2
Games (G:)
Games (G:)
Unallocated Space
\\.\PhysicalDrive3
Photos (P:)
Photos (P:)
Unallocated Space
Name
Status
Partitioning
Total Size
Total Sectors
Bytes/Sector
\\.\CDRom0 Not Ready ONE (Basic) 0 bytes 0 1
\\.\CDRom1 Not Ready ONE (Basic) 0 bytes 0 1
\\.\PhysicalDrive0 Ready, Initialized MBR (Basic) 238 GB 500118192 512
\\.\PhysicalDrive1 Ready, Initialized MBR (Basic) 932 GB 1953525168 512
\\.\PhysicalDrive2 Ready, Initialized MBR (Basic) 932 GB 1953525168 512
\\.\PhysicalDrive3 Ready, Initialized MBR (Basic) 932 GB 1953525168 512
\\.\PhysicalDrive4 Ready, Initialized MBR (Basic) 932 GB 1953525168 512
\\.\PhysicalDrive5 Ready, Initialized MBR (Basic) 466 GB 976773168 512
\\.\PhysicalDrive6 Not Ready, Not Initialized RAW (Basic) 0 bytes 0 1
\\.\PhysicalDrive7 Not Ready, Not Initialized RAW (Basic) 0 bytes 0 1
\\.\PhysicalDrive8 Not Ready, Not Initialized RAW (Basic) 0 bytes 0 1
\\.\PhysicalDrive9 Not Ready, Not Initialized RAW (Basic) 0 bytes 0 1
Disk Image Ready, Initialized MBR (Basic) 122 MB 249856 512
Disk Image Ready, Initialized MBR (Basic) 7.59 GB 15924384 512
Open
Cancel

Figure 35: Open disk or volume in Disk Editor

Add Disk Image

Mount disk image made by one of the LSoft Technologies utilities, such as `Active@ UNDLETE` or by third party applications. When mounted, disk image content will be added to navigation tree and will be loaded automatically t next session.

See *Open Disk Image* on page 57 for more information about *Disk Image* options and attributes.

Note: You can open (mount) disk image at any time separately by using **File** > **Add Disk Image...** from main menu.

Item's filter

Filters editable objects such as *disks*, *volumes* (logical drives), *files* or all disk objects at once for easier navigation.

Refresh

Refreshes list of disks and their content. Could be useful while changing removable devices.

Show navigator

Show or hide navigation (tree) pane on a left side of the dialog.

Properties

Show or hides properties pane

Open as Read Only

Toggles default object **read only** state opened for editing

Open in Disk Editor dialog shows detailed information about the selected object in the property panel.

Warning: As with any advanced tool, use extreme caution with the **Disk Editor**. Changes that you make may affect disk structure integrity. You must be certain that the changes you make are in line with correct data structures before you save changes.

Working with editor

The **Disk Editor** allows you to edit the content of a selected part of an opened object. By default, the Disk Editor shows the content of an object in a *Read Only* mode that prevents accidental modifications. In *Edit* mode, you can change the content of the opened file or disk and all modifications are stored in memory. Changes are written to the drive when you click **Save**.

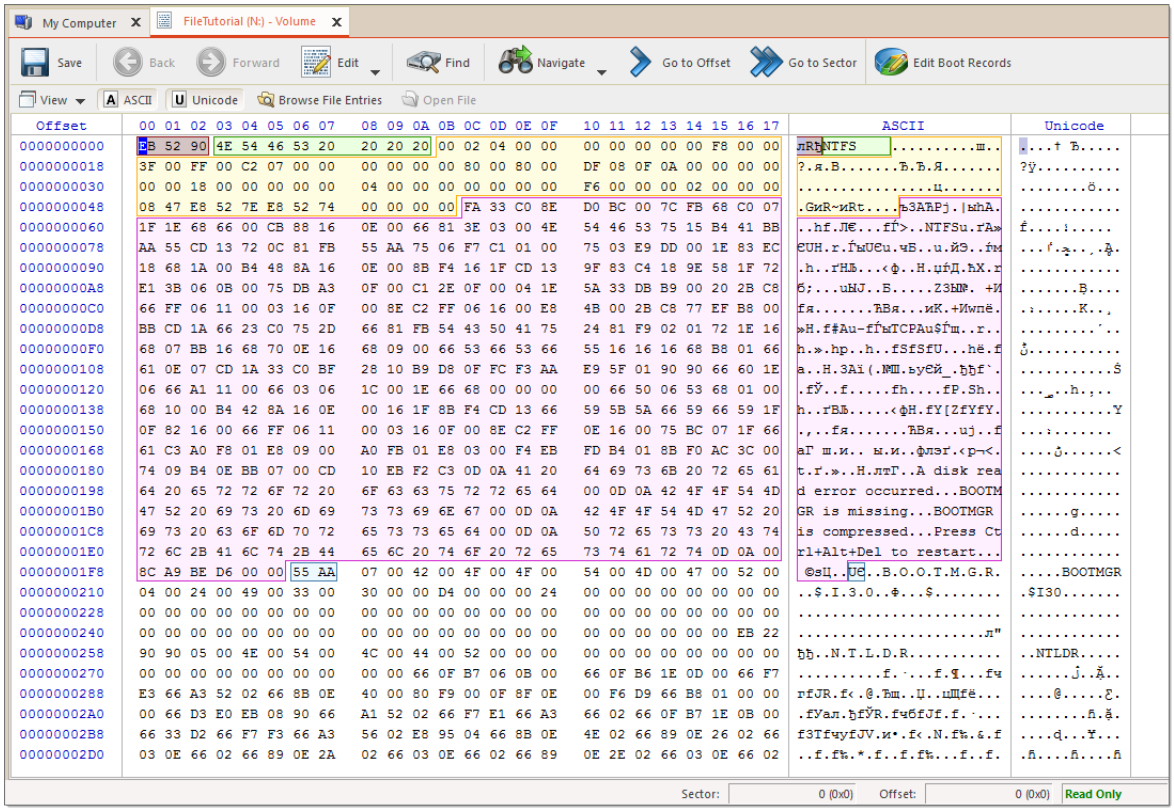


Figure 36: Disk Editor tab - editing volume example

To toggle between *Read Only* and *Edit* modes, do one of the following:

- From the Disk Editor toolbar, choose **Edit** > **Allow Edit** content.
- Right-click in the edit pane choose **Allow Edit** content from the context menu.

When you copy selected text from the edit pane to the clipboard, you may store it there in one of two formats using the following commands:

- **Copy** - selected data is copied into the clipboard as binary.
- **Copy Formatted** - selected data is copied as formatted text suitable to paste into a text editor.

Navigation

After you have opened an object with the **Disk Editor**, you may navigate by scrolling block by block, or by jumping directly to specific addresses. You may jump to disk system records such as the boot sector (primary and copy) or a partition table.

Read *Subject navigation and information* on page 93 articles for more.

Data selection

In order to select data in the **Disk Editor Area**, click and hold down the left mouse button and start dragging to select an area. The selected area background will be highlighted. Release the mouse to finish selecting. You can select an area bigger than will fit into the screen by dragging the mouse beyond the top or bottom edge of the hex editor window.

The alternative way to make a selection is to define a beginning and an end of the block. This method might be more convenient when a large area has to be selected in order to simply select data in a particular range. Move the cursor to the position where you want the selection to start and do one of the following:

- Select the menu command **Edit** > **Beginning of block** from the **Edit** menu in the toolbar.
- Right click and select **Edit** > **Beginning of block** from a context menu.
- Press **Ctrl+1**.

Move the cursor to the end of the desired selection and set the end of a selection in a similar way. If you need to select all the data, you can use the Select All command instead.

To apply massive changes to selection (block) use *Filling a selection* on page 96 feature.

Working with the clipboard

Select an area of data as described above and either select the command **Edit** > **Copy** or press **Ctrl+C**. The selected area will be copied into the clipboard in binary format. If you later want to insert it into a text editor, use the **Copy Formatted** command instead. It will copy data as a formatted text.

When you copy selected text from the edit pane to the clipboard, you may store it there in one of three formats:

- Binary – hexadecimal representation of selected data
- Text – text representation of selected data
- Display – formatted hexadecimal and text representation of selected data (as it appears in the editor)

Note: Please note that you can copy a maximum of 1MB of data into the clipboard.

Pasting data from the clipboard

If you copied data into the clipboard, you can paste it into a different place by moving the cursor to the position where you want the data to be copied. Use the command **Edit** > **Paste** or press **Ctrl+V**.

If you copied a text into the clipboard in a text editor, it will be pasted into the **Disk Editor** as text. Otherwise, the data will be copied as binaries.

Saving Changes

Unless stated otherwise, all modifications made in the Hex Editor are stored in memory. Changes are written to the drive when you click **Save**.

Edit physical disks

To navigate to the disk system records of a physical disk, click on the **Navigate** button in the toolbar. Depending on the partition scheme and contents of the physical disk you are editing, the **Navigate** menu will contain different options.

Navigating basic disks

After the **Go to Offset** and **Go to Sector** items there is a **Partition Table** menu item which allows jumping to sector 0 of a physical disk. As you jump to the partition table, a *Master Boot Record* template is automatically selected.

If the disk is not empty, the names of the partitions and their system areas will be in sub menus below the **Partition Table** menu item.

Navigating dynamic disks

For dynamic disks the following system areas are available for direct access:

- LDM Private Header
- LDM Primary TOC Block
- LDM Backup TOC Block
- LDM VMDB Block
- LDM KLog
- LDM First VBLK Block

After each access point a sector number is specified in the brackets.

Edit logical drives

To navigate to the disk system records of a logical drive, click on the Navigate button in the toolbar.

Depending on the file system present in a logical drive, the navigation menu will have different access points.

FAT and FAT32 drives

- Boot Sector
- Boot Sector Copy (FAT32 only)
- FAT1
- FAT2
- Root Directory

NTFS drives

- Boot Sector
- Boot Sector Copy
- $MFT
- $MFT Mirror
- Arbitrary MFT record

HFS+ drives

- Volume Header
- Volume Header Copy

Ext2/Ext3 drives

- Superblock

Some of the access points when used automatically select a corresponding template. For example, if a boot sector access point is selected, a boot sector template is applied to the boot sector offset.

Browsing file records

When editing *volume* (*logical drive*) you also can navigate file records. To activate this feature toggle on **Browse File Entries** button in toolbar. By selecting file or folder in file's tree editor's pane will automatically repositions

to beginning of file entry record. If recognised, file can be previewed in File Preview pane and Property pane will display file's most common attributes and properties.

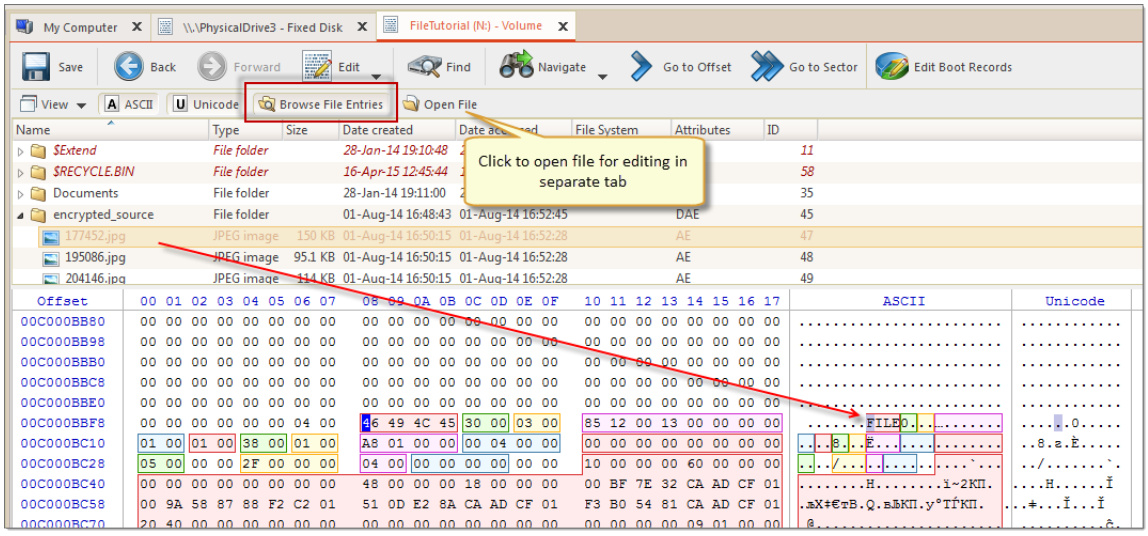


Figure 37: Browsing volume file entries

To open selected file in separate `Disk Editor` either click **Open File** button in toolbar or **Double click** on selected file for the same result.

Edit files and file records

Open file in Disk Editor

To open file in Disk Editor select it Scan Result view or Search Result view and click **Open in Disk Editor** button to edit file's contents or use **Inspect File Record** command to edit file's record. You may use context menu for same result.

Tip: You can use the **Ctrl+H** shortcut to open any selected item in `Disk Editor`.

Editing file

Disk Editor allows to edit file in several view modes:

Disk mode

File presented as raw data in context of physical data storage (disk)

Partition Mode

File presented as data on parent logical structure - partition or volume (logical drive)

File mode

Single file - seamless ray file contents.

File editing is the same as with any other editable object in Disk Editor. Read *Working with editor* on page 88 for more information.

Warning: For safety reason, by default all objects are opened in Disk Editor as *Read Only* to prevent accidental modifications. In *Edit mode*, you can change content of the opened file or disk and all modifications are stored in memory. Changes are written to the drive when you click **Save**.

Warning: As with any advanced tool, use extreme caution with the **Disk Editor**. Changes that you make may affect disk structure integrity. You must be certain that the changes you make are in line with correct data structures before you save changes.

Inspect file record

Information about file in File Table could be viewed for file by doing one of the following:

- Select file in browser and click **Inspect File Record** button in toolbar or use the same command from context menu;
- While editing file in Disk Editor click **Inspect File Record** button in view's toolbar
- While *editing volume* (logical drive) click **Browse File Records** in view's toolbar to open File Records navigation pane.

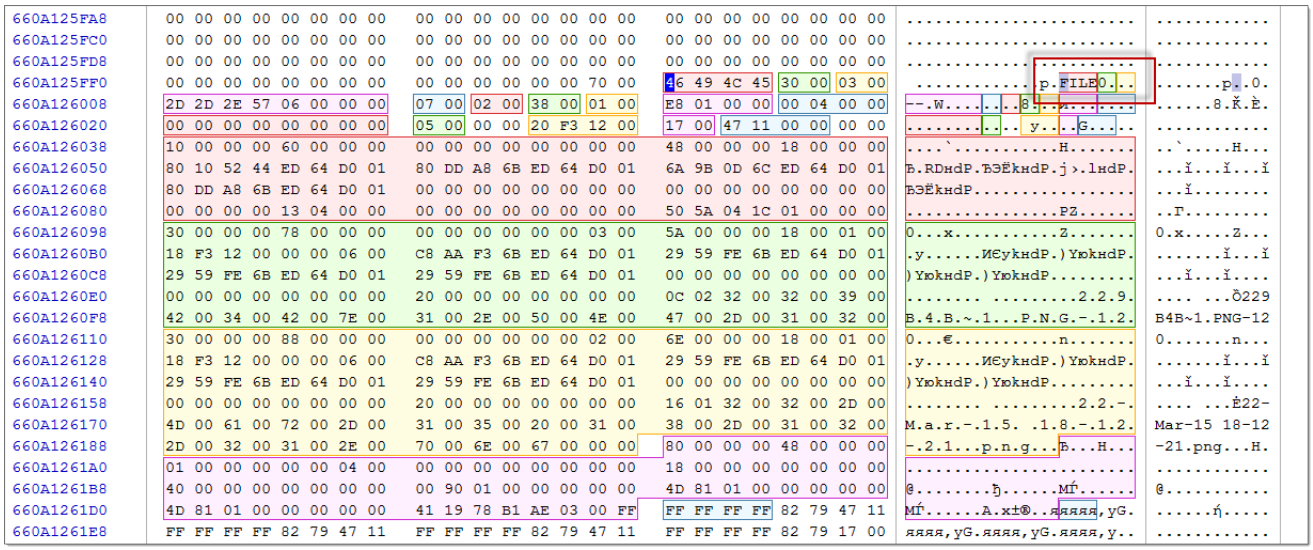


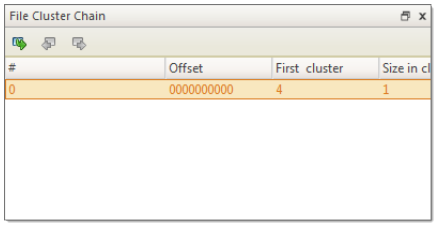
Figure 38: File record on NTFS

Use data templates to inspect file record. Depending on file system, they can be named as file record templates, directory entries or superblocks.

File Cluster Chain view

To open the File Cluster Chain View:

- from the **Disk Editor toolbar**, choose **View** > **File Cluster Chain**
- form main menu choose **View** > **Window** > **File Cluster Chain**



Go to

Go to selected cluster of cluster chain. Same effect can by achieved by double-clicking on cluster entry in cluster chain list.

Go to Previous

Go to previous cluster chain in sequence

Go to Next

Go to next cluster chain in sequence.

Subject navigation and information

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Basic Navigation

After you have opened an object with the **Disk Editor**, you may navigate by scrolling block by block, or by jumping directly to specific addresses. You may jump to disk system records such as the boot sector (primary and copy) or a partition table.

Use the **Navigate** button in the toolbar to jump to a specific area in the open object.

When you navigate to an access point through the **Navigate** menu or jump to a specific offset or sector, those addresses are stored in a stack. You can move backward and forward to the previous locations by using the **Back** and **Forward** commands located in the **Disk Editor Toolbar**.

The selections that appear depend on the type of object that you are editing.

Direct Navigation

No matter what object is opened for editing, the first two menu items in the **Navigate** menu will be **Go to Offset** and **Go to Sector**.

Read *Move to offset* on page 93 and *Move to sector (cluster)* on page 94 articles for more information.

Logical navigation

After you have opened an object with Hex Editor, you may navigate by scrolling block by block, or by “jumping” directly to specific addresses. You may jump to disk system records, such as the boot sector (primary and copy) or partition table. In a file’s cluster chain list, you may jump to the first cluster of a continuous cluster chunk when working with a file.

To open the **Navigate** menu:

- In the Hex Editor toolbar, open the **Navigate** drop-down menu.
- Right-click in the editor pane and open the **Navigate** sub menu in the context menu.

The selections that appear depend on the type of object that you are editing.

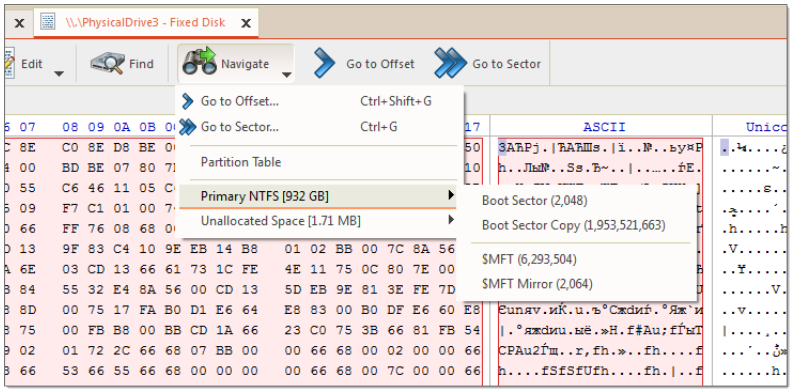


Figure 39: Example. Navigate Menu Selections

Use Property view and SMART Info for detailed information about subject attributes - *Property views* on page 128.

Move to offset

The **Go to Offset** menu opens a dialog allowing specification of an exact location (offset) in the disk to jump to.

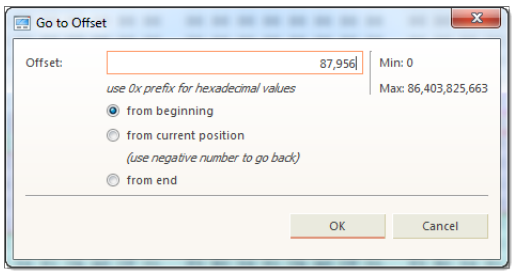


Figure 40: Go to Offset dialog

You can use both decimal and hexadecimal values, preceding hexadecimal values with 0x. For example, to specify location 512 as a hexadecimal number, enter 0x200. There are also options to specify an offset from the beginning, from the current position, or from the end.

Next to the offset edit field there are two labels specifying the minimum and maximum allowed vales for offsets displayed as decimal numbers.

You can also open this dialog directly by using the shortcut **Ctrl+Shift+G**.

Move to sector (cluster)

This command allows jumping to the beginning of a specified sector or cluster.

There are two edit fields in this dialog that allow entering a desired location either as a sector number or a cluster number.

The **Cluster edit field** is available only for logical disks and greyed out for all other objects.

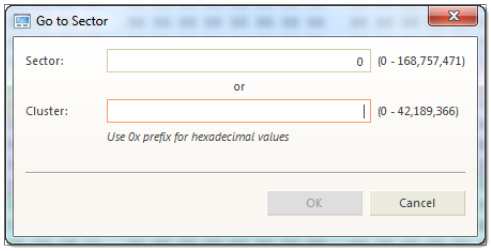


Figure 41: Go to Sector dialog

As with the offset dialog, you can also use both decimal and hexadecimal numbers.

Next to the edit field is the range of allowed values in brackets. Notice that not all sectors correspond to clusters, but every cluster corresponds to a particular sector.

You can enter either a sector value or a cluster value. Depending on which field is active, the dialog will use a sector or cluster. If you enter a number in the cluster edit field, a corresponding sector is displayed automatically.

You can also open this dialog directly using the shortcut **Ctrl+G**.

Navigate a Physical Disk

To navigate to the disk system records of a physical disk, click on the **Navigate** button in the toolbar. Depending on the partition scheme and contents of the physical disk you are editing, the **Navigate** menu will contain different options.

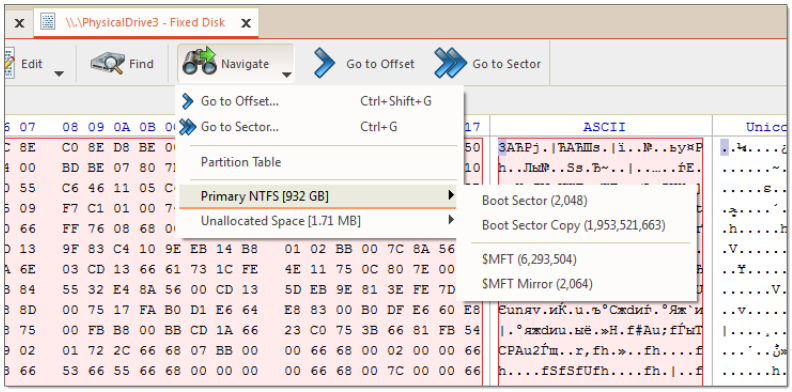


Figure 42: Example. Navigate Menu Selections

Navigating basic disks

After the **Go to Offset** and **Go to Sector** items there is a **Partition Table** menu item which allows jumping to sector 0 of a physical disk. As you jump to the partition table, a *Master Boot Record* template is automatically selected.

If the disk is not empty, the names of the partitions and their system areas will be in sub menus below the **Partition Table** menu item.

Navigating dynamic disks

For dynamic disks the following system areas are available for direct access:

- LDM Private Header
- LDM Primary TOC Block
- LDM Backup TOC Block
- LDM VMDB Block
- LDM KLog
- LDM First VBLK Block

After each access point a sector number is specified in the brackets.

Navigate a Logical Drive

To navigate to the disk system records of a logical drive, click on the Navigate button in the toolbar.

Depending on the file system present in a logical drive, the navigation menu will have different access points.

FAT and FAT32 drives

- Boot Sector
- Boot Sector Copy (FAT32 only)
- FAT1
- FAT2
- Root Directory

NTFS drives

- Boot Sector
- Boot Sector Copy
- $MFT
- $MFT Mirror
- Arbitrary MFT record

HFS+ drives

- Volume Header
- Volume Header Copy

Ext2/Ext3 drives

- Superblock

Some of the access points when used automatically select a corresponding template. For example, if a boot sector access point is selected, a boot sector template is applied to the boot sector offset.

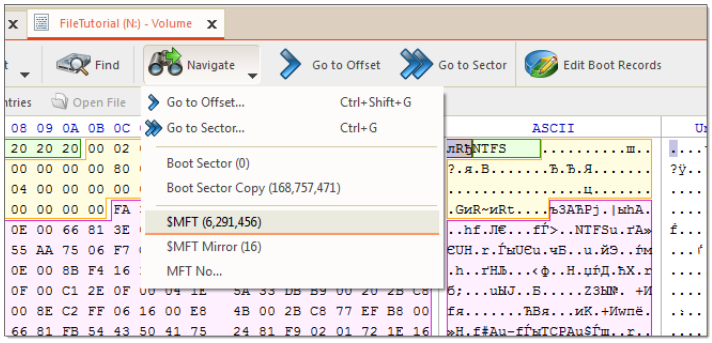


Figure 43: Example. Navigate Menu Selections

Browsing File Entries

When editing *volume* (*logical drive*) you also can navigate file records. To activate this feature toggle on **Browse File Entries** button in toolbar. By selecting file or folder in file's tree editor's pane will automatically repositions to beginning of file entry record. If recognised, file can be previewed in File Preview pane and Property pane will display file's most common attributes and properties.

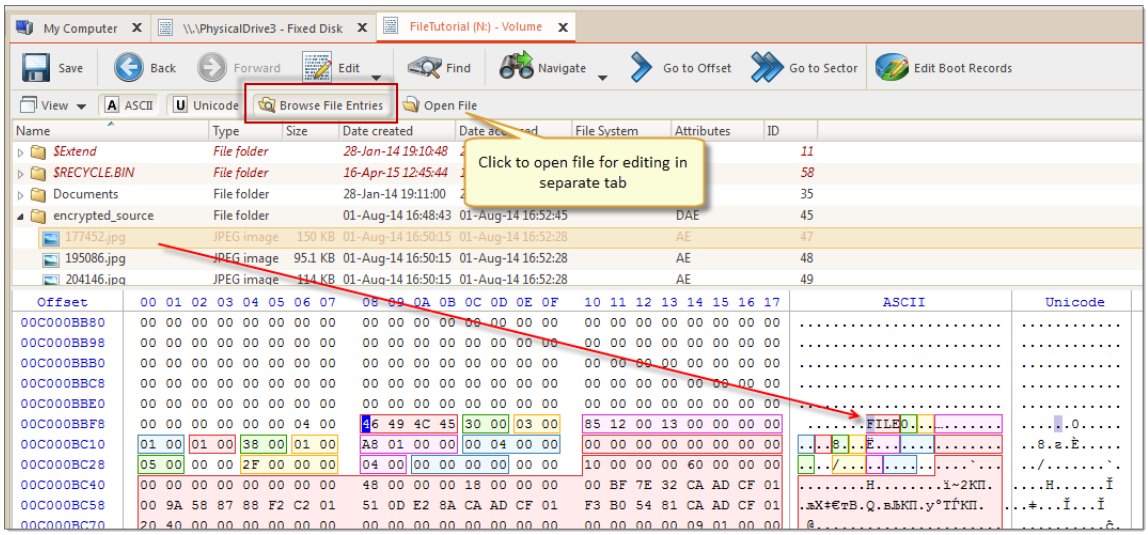


Figure 44: Browsing volume file entries

To open selected file in separate `Disk Editor` either click **Open File** button in toolbar or **Double click** on selected file for the same result.

Filling a selection

You can fill a selection with an arbitrary text or binary data. Make a selection first, then right click **Edit** > **Fill block**. The **Fill Block** dialog allows entering either text or hex value patterns which will be used to fill the selection. Patterns are used in a loop until the whole selection is filled. For example, if you need to fill a selection with 0 bytes, just enter

00 into the Hex values edit field. If you want fill it with an '**ERASED**' pattern, enter it as a text and it will be repeated as many times as necessary to fill the block.

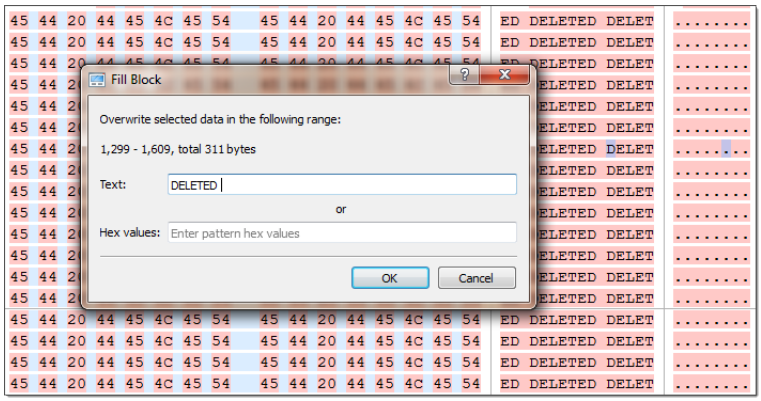
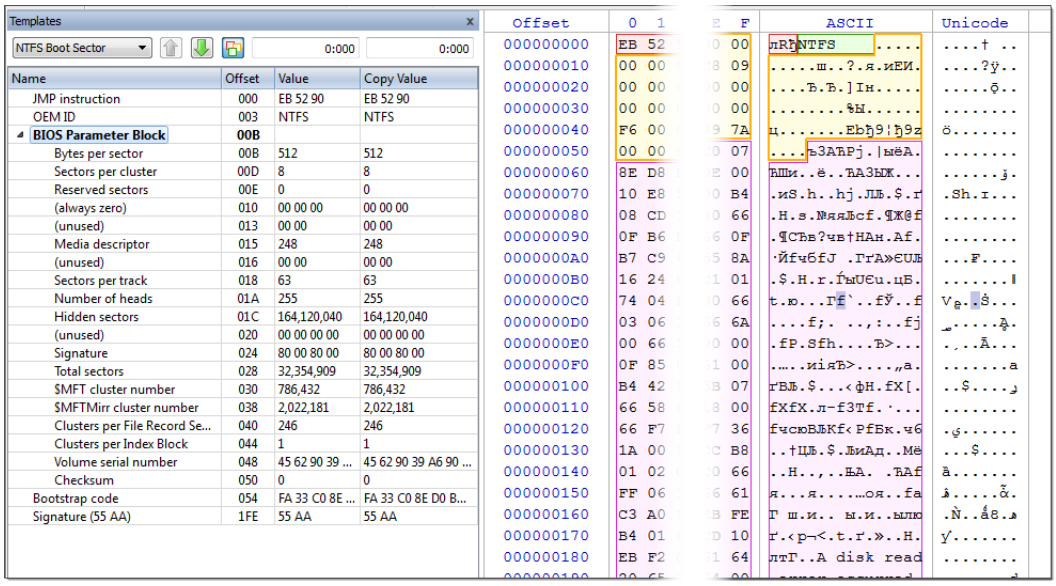


Figure 45: Fill Block dialog

Using Templates

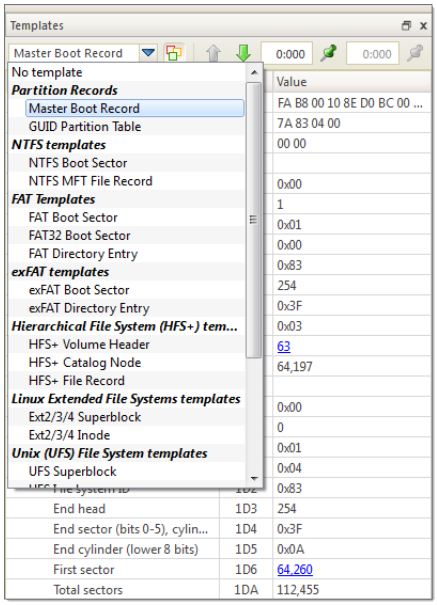
Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

You can edit system records (like boot sectors, MBR, MFT etc.) by using a template tool window. Template window is a small dockable window normally located to the left from main Disk Editor editing area. If it is not visible, you can turn it on by selecting toolbar menu **View** > **Templates**.



Applying a template

In order to apply a template to the desired offset, move the cursor to the location and use **Edit** menu command **Set Template position**. You can select this command either from Edit toolbar menu or from a context menu. The next step select a required template from the list box with template names in the toolbar of templates window.



When you are jumping to particular system areas using **Navigate** menu, the corresponding template might be applied automatically. This is true for templates like boot sectors, MBR or MFT record but not all access points have a template associated with them.

The following templates are supported:

Partition records

- Master Boot Record (MBR)
- GUID Partition table

NTFS templates

- NTFS Boot Sector
- NTFS MFT File Record

FAT templates

- FAT Boot Sector
- FAT32 Boot Sector
- FAT Directory Entry

exFAT templates

- exFAT Boot Sector
- exFAT Directory Entry

Hierarchical File System (HFS+) templates

- HFS+ Volume Header
- HFS+ Catalog Node
- HFS+ File Record

Linux Extended File System templates

- Ext2/Ext3/Ext4 Boot Sector
- Ext2/Ext3/Ext4 Inode

Unix File System (UFS) templates

- UFS Superblock
- UFS Inode

B-tree (BtrFS) File System templates

- BtrFS Superblock

Logical Disk Manager (LDM) templates

- LDM Private Header
- LDM TOC
- LDM VMDB
- LDM Klog
- LDM VBLK

As you edit data in Hex, ASCII or Unicode pane or in Templates window, modified data is fully synchronized between views. After each modification a template view is recalculated giving you an up-to-date interpretation of data.

Template Copy

The following templates have their copy:

- NTFS Boot Sector
- FAT32 Boot Sector
- HFS+ Volume Header
- Ext2/Ext3 super block
- LDM Private Header
- LDM TOC Block

In this case template window will have an additional column named *Copy Value* which contains the data from the copy record. Template copies are useful to compare record located in different locations using the same pattern, for example to compare a boot record with its copy.

In case of *Copy* template its location is set separately from a main record using the same pattern. If the main template and its copy are intersecting, the copy template data will be shown in template window but not highlighted in the main edit area.

Setting template position

In order to set a template position or change an existing one move the cursor to desired location and use **Edit** menu command **Set Template position** (or **Set Template Copy Position** for its copy).

Navigating to a system area which has an attached template using **Navigate** menu also changes template position.

In order to facilitate the movement between records located in sequence, use arrow buttons located in the template window toolbar next to the templates list. For example, if you are editing or viewing an MFT record you can easily move to the next or previous record using those buttons.

Another way to set a template position is to enter new offset directly into template offset edit field in the template window toolbar. One of those fields are used for entering an offset of the main record and another is for its copy. The format of offset used in offset field is <sector:>:<sector offset>. You don't need to specify sector offset if you want to move to the beginning of the sector. For example, you can simply enter 100 to go to sector 100 and template offset will be shown as 100:0, but if you need to specify 128 byte in sector 100, you have to enter 100:128.

Highlighting template fields

By default all individual fields of template record are highlighted in Disk Editor main area (in hexadecimal and ASCII columns only). This coloring highlighting can be disabled by clicking Toggle template fields coloring button in template window toolbar next to arrow buttons.

The colors used by template coloring are arbitrary and have no specific meaning, their main purpose is to make separate fields visible and distinguish from each other. Actually, a palette of several colors is chosen and colors are

used in a circle. When you select a field in the template window, the current field is also highlighted in hex editing area with bold field frame.

When you move a mouse cursor above colored field in editing area, the name and value of the corresponding field is also shown in a tooltip.

Navigating around template fields

You can set the cursor (current position) to a particular field in a template by double clicking it. If you double click in *Name*, *Offset* or *Value* column, the position inside the main record is selected, but if you click inside *Copy Value* column, the navigation is performed to the field in template copy.

Please note, that in Edit mode double clicking inside of *Value* or *Copy Value* starts editing of the field instead of navigating to that field.

Editing using template

Double click in the *Value* or *Copy Value* column to start editing the field (make sure that **Allow Edit Content** is enabled).

Some of the fields are edited according to the mask and will not allow to enter invalid values. For example, you cannot enter the number bigger than 65535 when editing a 2-byte field or invalid date when editing a date.

To exit the editing of the field with saving the result of edit, press Enter or click to another field. To exit editing without saving the result and revert to original value, press **Esc**.

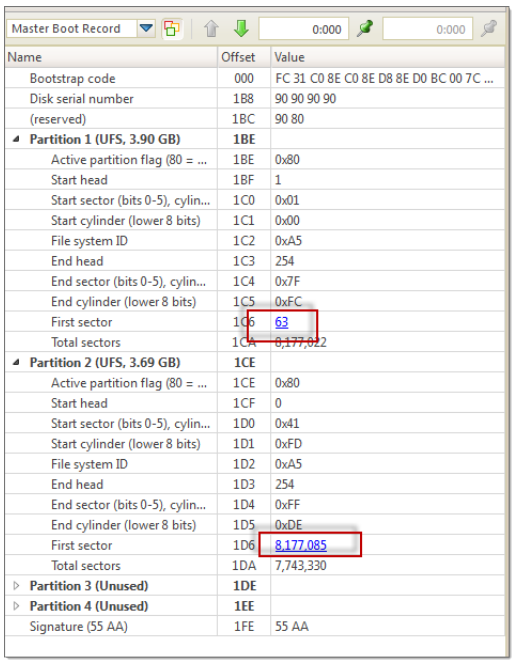
Some of the templates fields depend on other fields. When a template is selected, an initial parsing occurs. If some of the fields contain invalid values, the further parsing of the record might be not possible and parsing will be stopped at this point, resulting in incomplete record. As an example lets take an MFT record. The record header is always parsed, but if it contains invalid fields or update sequence, attributes will not be parsed. The same is true when parsing an attribute - if an error occurs, the further parse is canceled and no subsequent attributes are added to the record.

Furthermore, the whole set of fields for the template might depend on some field values. For example, FAT Directory Entry template will show a Short File Name Entry fields or Long File Name depending on the value of the flags.

Hyperlinks in templates

Many templates contain hyperlinks allowing navigate easily to important data points.

For example, MFT records contain links to first cluster in data runs and MBR provides links to partitions.



Name	Offset	Value
Bootstrap code	000	FC 31 C0 8E C0 8E D8 8E D0 BC 00 7C ...
Disk serial number	1B8	90 90 90 90
(reserved)	1BC	90 80
Partition 1 (UFS, 3.90 GB)	**1BE**	
Active partition flag (80 = ...	1BE	0x80
Start head	1BF	1
Start sector (bits 0-5), cylin...	1C0	0x01
Start cylinder (lower 8 bits)	1C1	0x00
File system ID	1C2	0xA5
End head	1C3	254
End sector (bits 0-5), cylin...	1C4	0x7F
End cylinder (lower 8 bits)	1C5	0xFC
First sector	1C6	63
Total sectors	1CA	8,177,022
Partition 2 (UFS, 3.69 GB)	**1CE**	
Active partition flag (80 = ...	1CE	0x80
Start head	1CF	0
Start sector (bits 0-5), cylin...	1D0	0x41
Start cylinder (lower 8 bits)	1D1	0xFD
File system ID	1D2	0xA5
End head	1D3	254
End sector (bits 0-5), cylin...	1D4	0xFF
End cylinder (lower 8 bits)	1D5	0xDE
First sector	1D6	8,177,085
Total sectors	1DA	7,743,330
Partition 3 (Unused)	**1DE**	
Partition 4 (Unused)	**1EE**	
Signature (55 AA)	1FE	55 AA

Disk Editor tools and views

`Disk Editor` delivers several tools for advanced users:

Data Inspector **on page 101**

Tool-view interpret currently selected data to several most used data types.

File preview

Allows to preview content of a file. Supports basic image formats and registered document types, such as MS Office, PDF's etc.

File cluster chain **on page 102**

Provides advanced navigation through file structure.

Active Bookmarks **on page 103**

Provides ability to mark certain locations on edited subject to faster access and navigation.

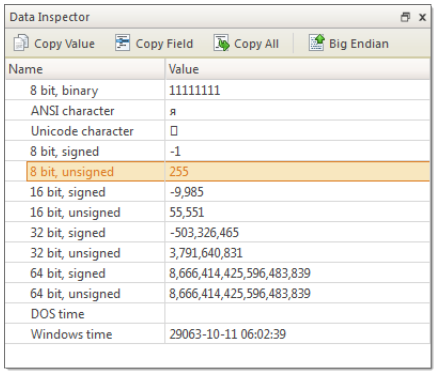
Searching in Disk Editor **on page 104**

Enhanced search within edited content.

Data Inspector

The **Data Inspector** is a small viewing tool that provides the service of “inspecting” (or interpreting) data currently selected in the edit pane. The Data Inspector lets you view the type of data you have selected. This can help you interpret data as displayed in **Disk Editor**.

To open the Data Inspector, from the **Disk Editor toolbar**, choose **View** > **Data Inspector**;



Copy Value

Copy value of selected field to clipboard.

Copy Field

Copy entire selected field (value and field name) to clipboard.

Copy All

Copy all name and value fields in a view to clipboard.

Big Endian

Toggle between *little endian* and *big endian* value representation.

Use view context menu to execute these commands for selected item (field).

The Data Inspector window is dockable and its location can be changed by clicking on the window title and dragging it to the new one. If the Data Inspector window is sharing its space with other tool views, you can change its relative position by left clicking and dragging the window tab. You can close the window by clicking on the [**X**] button in the top right corner of the window and reopen it again using the **View** menu in the **Disk Editor Toolbar**.

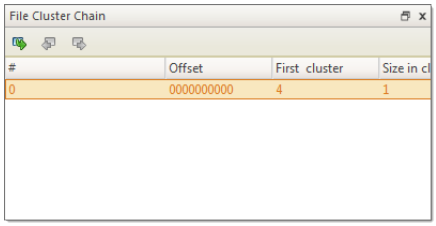
File cluster chain

File cluster chain is one of the essential approach to analyse file data integrity and file recovery/ To help navigate through the content of an open file, file's cluster chain, shown sequence number, offset and size of each chain, is displayed in **File Cluster Chain view**.

File Cluster Chain view

To open the File Cluster Chain View:

- from the **Disk Editor toolbar**, choose **View** > **File Cluster Chain**
- form main menu choose **View** > **Window** > **File Cluster Chain**



Go to

Go to selected cluster of cluster chain. Same effect can by achieved by double-clicking on cluster entry in cluster chain list.

Go to Previous

Go to previous cluster chain in sequence

Go to Next

Go to next cluster chain in sequence.

Active Bookmarks

Bookmarks allow you to save the current cursor location and quickly return to it later on. You may also give a name to a bookmark to make orientation easier.

Bookmarks are shown in the tool window called Bookmarks. If the Bookmarks window is closed you can open it using the menu **View** > **Bookmarks**.

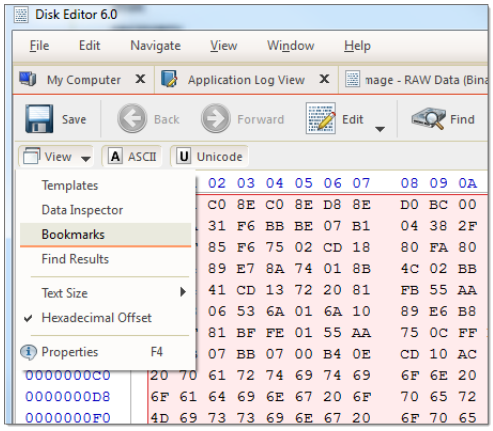


Figure 46: Open bookmarks view

Bookmark view

All bookmark for currently edited object are listed in **Bookmark view**. Bookmark will be saved for next session use if edited object is saved or left open before application exit.

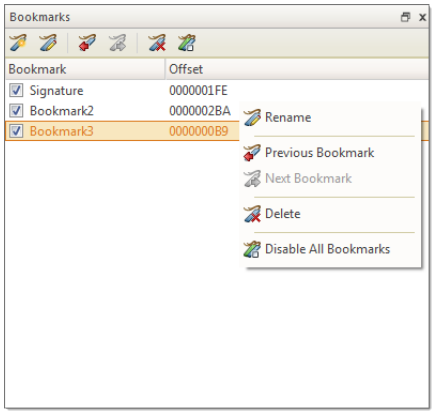


Figure 47: Bookmarks and Bookmarks view

Toggle bookmark

Add or remove bookmark at current cursor position

Rename

Rename selected bookmark

Go to previous

Move (jump) cursor to previous bookmark

Go to next

Move (jump) cursor to next bookmark

Delete

Delete selected bookmark

Disable all bookmarks

Disable bookmarks, thus they will be ignored in bookmark's shortcut navigation.

Tip: Use context menu for selected bookmark for the same set of commands as in view's toolbar.

Placing and removing a bookmark

Move cursor to position of interest in the Disk Editor and press **Ctrl+F2** in order to add a bookmark or toggle a **Toggle a Bookmark** button in the **Bookmark view** toolbar. Alternatively, you can right click in the hex editor and select a command from a context menu. The bookmark position is shown with a light blue box in the Disk Editor and also added to the list of bookmarks in the **Bookmarks view**.

To remove a bookmark, press **Ctrl+F2** while having the cursor over the position of that bookmark. You can also remove a bookmark from the Bookmarks view by selecting a bookmark in the list and clicking **Delete** button in a toolbar. The delete function can also be selected from a context menu.

Going to a bookmark

If you have defined bookmarks, pressing **F2** will move your current position to the next enabled bookmark in the list.

You can also right click a bookmark and select the **Next** bookmark command from a context menu. Another option is to double click a bookmark name in the **Bookmarks** window.

Editing bookmarks

Bookmarks are named automatically when they are placed. You can rename a bookmark in the Bookmarks window to give it some meaningful name. To do so make a single mouse click on the bookmark name and edit it. Press **Enter** to accept your changes or **Esc** to cancel editing and revert to the original name. You can also rename a bookmark by right-clicking on it and selecting the **Rename** command from a context menu.

All bookmarks are highlighted in Disk Editor view for easy navigation

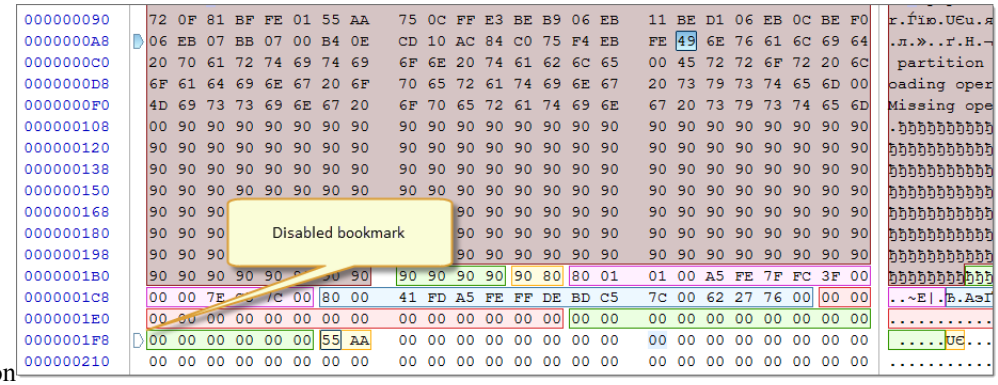


Figure 48: Bookmarks in Editor view

Sometimes instead of deleting a bookmark it is useful to temporarily disable it. A disabled bookmark will not be counted when moving to the next bookmark. Uncheck a bookmark in the Bookmarks window to disable it. To disable all bookmarks at once click **Disable** all bookmarks in a toolbar or select this command in a context menu.

Searching in Disk Editor

To search text or byte sequence in **Disk Editor** view :

- Click **Ctrl+F** shortcut key or
- Use **Find** button in Disk Editor's toolbar then **Find text** dialog will appear.

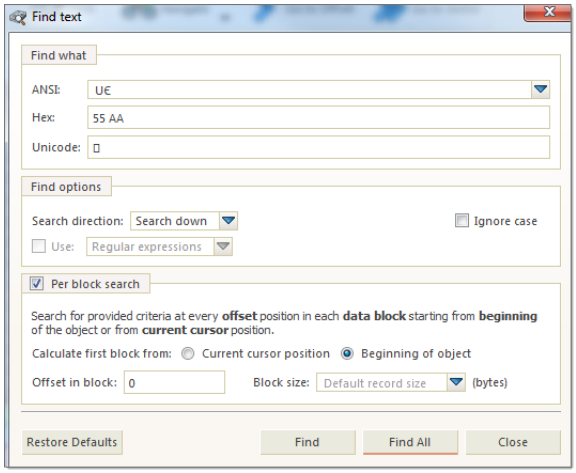


Figure 49: Dialog Find

Find what

Search pattern to find. Required. Can be set in one of the following formats:

- ANSI - text pattern, Regular expressions and wildcards can be used. History of ANSI search patters is preserved for next sessions and can be selected from drop-down list.
- HEX - search pattern in **hexadecimal** format.
- Unicode - search pattern in **Unicode** format.

Note: When search pattern is entered in one of the find what text fields, the other two related fields will interpret entered value in correspondent format.

Find options

Regular expressions and *wildcards* can provide even greater search capabilities.

Search direction will specify search direction from the current cursor position.

Per block search

When this option is on, then search applies on per block fragments of context object. This method could be useful to search for repeated pattern, for instance at certain position (offset) in each and every sector (block).

Find command will initiate search process and will pause at first search result entry. Use **Next** button on dialog or **F3** keyboard shortcut to continue paused search.

When using **Find All** command, list of all search entries will appear in **Find Results** view. Use this list to navigate between search result entries (if any).

Browsing search results

After search completed, result entries (if any) are listed in **Find Results** view, grouped in subsequent search results, with offset (address) and short preview snippet. To focus on individual search result entry double-click on it in list or use **Goto** button in view's toolbar.

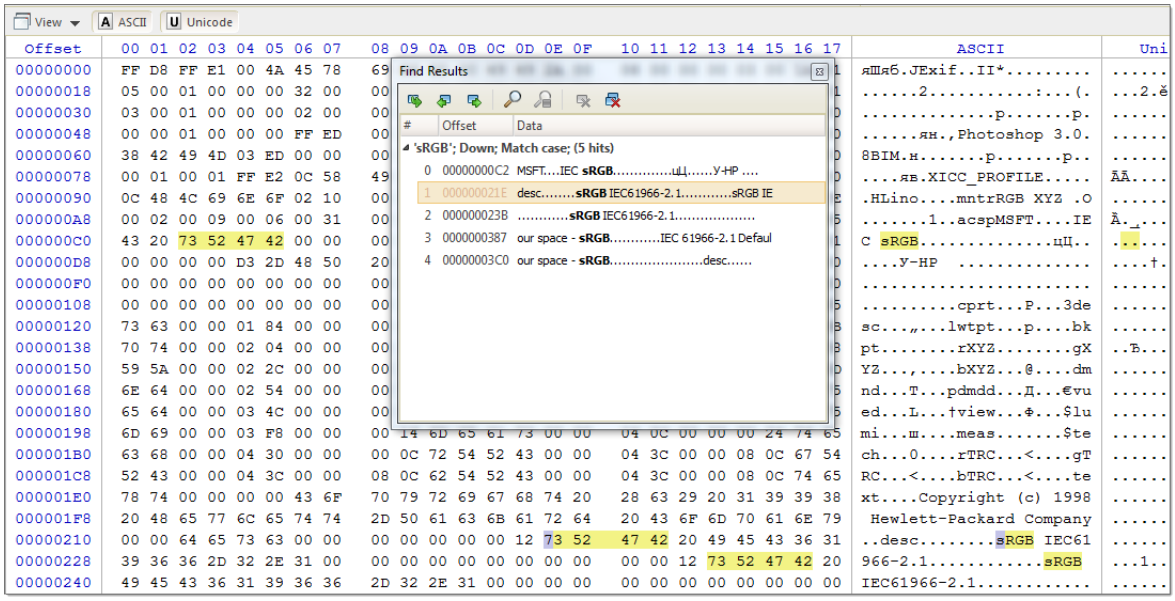


Figure 50: Find results in Disk Editor

All search results are highlighted in Disk Editor view.

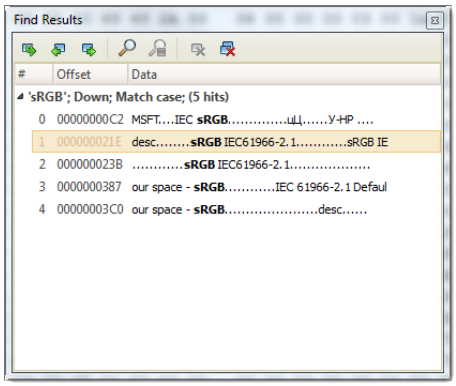

Find Results
'sRGB'; Down; Match case; (5 hits)
0 00000000C2 MSFT....IEC sRGB.....ЦЦ.....У-HP ....
1 000000021E desc.....sRGB IEC61966-2.1.....sRGB IE
2 000000023B .....sRGB IEC61966-2.1.....
3 0000000387 our space - sRGB.....IEC 61966-2.1 Defaul
4 00000003C0 our space - sRGB.....desc.....

Figure 51: Find Results view

Goto location

Move cursor and position Disk Editor view on selected search result

Goto Previous

Move cursor to previous search result

Goto Next

Move cursor to next search result

Find

Open Find dialog for a new search

Stop

Terminate current search process

Remove

Remove selected search result or search group from list

Remove All

Clear search result list

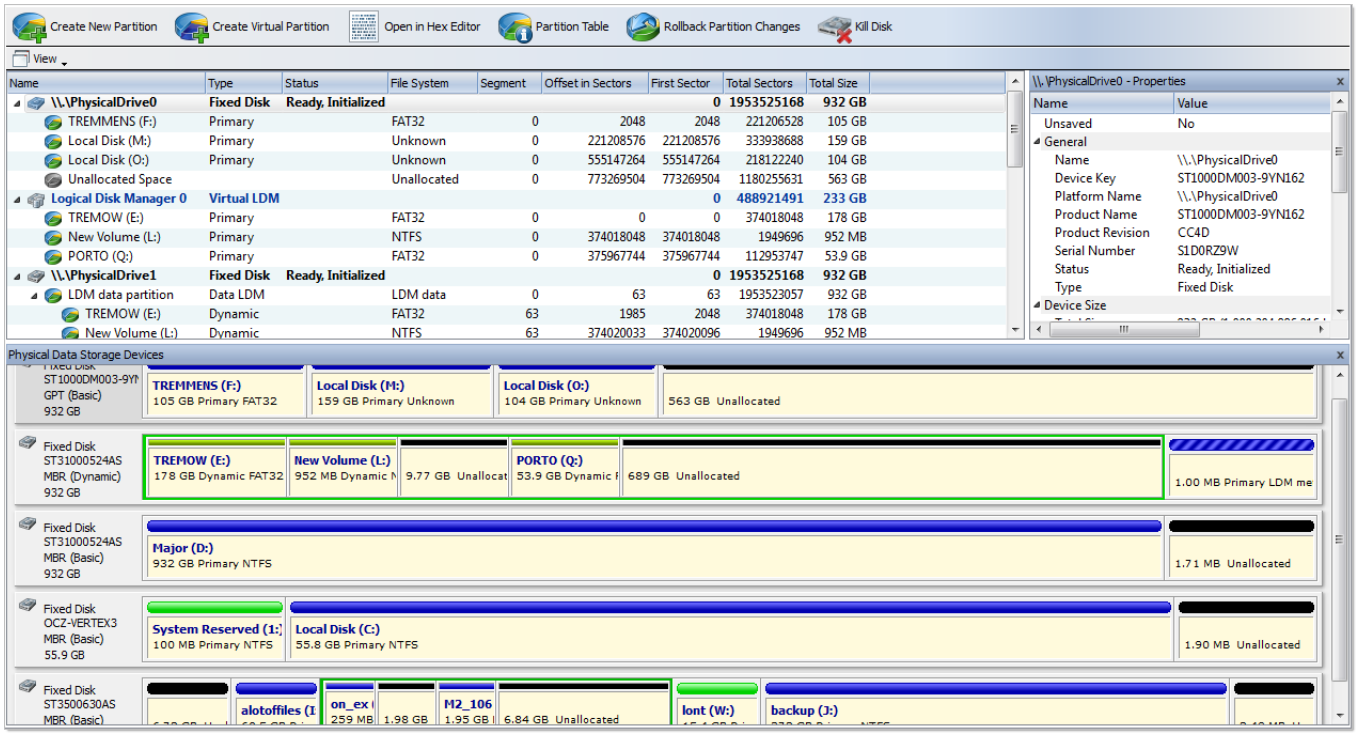
Use context menu in Find result view to interact with each search entry individually.

Partition Manager

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

`Partition Manager` is advanced `Active@ UNDELETE` tool, that allows you to perform disk partitioning tasks, such as creating partitions and volumes, formatting them, and assigning drive letters. Initialize raw disk, edit partition tables and more.

Most of these changes to disk partitioning are recorded in dedicated backup files thus at any time these changes could be rollback at certain point. See *Rollback partition changes* on page 111 for more information.



To open Partition Manager click **Tools** > **Partition Manager**in main application menu or use shortcut **Ctrl+M** at any time when running Active@ UNDELETE.

The main features of Partition Manager are:

- *Initialize new disk (physical device)* on page 107
- *Create partition* on page 108
- *Format partition* on page 111
- *Resize a partition or logical drive (volume)* on page 110
- *Edit boot sectors* on page 112
- *Edit partition table* on page 113

Initialize new disk (physical device)

Physical Disks Initialization

To make disk accessible for application it needs to be initialized first by one of the following partition style:

- Master Boot Record (MBR);
- GUID Partition Table

⚠ **Danger:** Do not initialize disk if you are about to recover lost data from it! Use *Scan for deleted partitions and files by their signatures* on page 18 to retrieve your files fist.

To initialize physical disk proceed as follows:

1. Select disk to initialize

   In **Partition Manager** select not-initialized Disk (Physical Disk).
2. Open the Initialize Disk dialog

   - From the **Partition Manager** toolbar click **Initialize** button or use command **Actions** > **Initialize**... from main menu;
   - Right-click the selected item and click **Initialize...** command from the context menu.

   Confirm disk selection and other options in opened dialog.

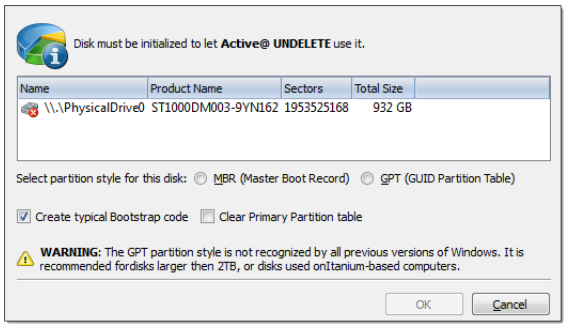

Disk must be initialized to let Active@ UNDELETE use it.
Name
Product Name
Sectors
Total Size
\\.\PhysicalDrive0
ST1000DM003-9YN162
1953525168
932 GB
Select partition style for this disk:
MBR (Master Boot Record)
GPT (GUID Partition Table)
Create typical Bootstrap code
Clear Primary Partition table
WARNING: The GPT partition style is not recognized by all previous versions of Windows. It is recommended fordisks larger then 2TB, or disks used onItanium-based computers.
OK
Cancel

Figure 52: Initialize Disk dialog

Partition style

Select either *MBR* (Master Boot Record) or *GPT* (GUID Partition Table) partition style.

Note: GPT partition style is not supported by older versions of Windows. It is recommended for disks larger then 2TB. For all other purposes we recommend to use MBR partition style

Create typical bootstrap code

Default generic bootstrap code will be written if this option is on.

Clear primary partition table

Primary partition table records will be cleared.

Warning: It is highly recommended to not clear primary partition table in case of restoring deleted or damaged disk partitioning.

3. Click **OK** to complete disk initialization

After disk initialization it should be visible and accessible in **Partition Manager** for other actions, such as *Create partition* on page 108 and more.

Partition manipulation

Partition Manager provides essential functionality to handle disk partitioning under windows environment, such as:

- *Create partition* on page 108
- *Change partition attributes* on page 110
- *Resize a partition or logical drive (volume)* on page 110
- *Format partition* on page 111

One of the unique feature of Partition Manager is *Rollback partition changes* on page 111 - ability to revert any if the actions mentioned above.

Create partition

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

To create new partition (*logical drive or volume*):

1. Select partition location

   In **Partition Manager** select a disk (*physical device*) or *unallocated space* node.
2. Open the **Create New Partition** dialog

   - From the toolbar click **Create New Partition** button or use command **Actions** > **Create New Partition...** from main menu.
   - Right-click the selected item and click **Create New Partition** command from the context menu.
3. Adjust dialog options

   Use sliders to specify partition boundaries - offset and size. Mouse click on unallocated space will select it to utilize all space available.

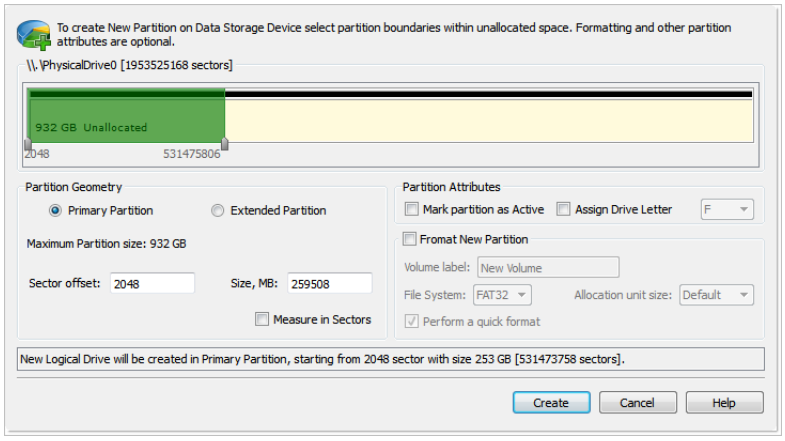

To create New Partition on Data Storage Device select partition boundaries within unallocated space. Formatting and other partition attributes are optional.
\\.\PhysicalDrive0 [1953525168 sectors]
932 GB Unallocated
2048
531475806
Partition Geometry
Primary Partition
Extended Partition
Maximum Partition size: 932 GB
Sector offset: 2048
Size, MB: 259508
Measure in Sectors
Partition Attributes
Mark partition as Active
Assign Drive Letter
F
Fromat New Partition
Volume label: New Volume
File System: FAT32
Allocation unit size: Default
Perform a quick format
New Logical Drive will be created in Primary Partition, starting from 2048 sector with size 253 GB [531473758 sectors].
Create
Cancel
Help

Figure 53: Create Partition dialog

Primary or Extended

Partition can be created as *Primary* partition (of number of available Primary partitions are not exceeded) or as *Extended* partition.

Sector Offset

First sector of created partition. It can be set exact by numerical value entered in text box or by moving left slider in **Device View** control;

Partition Size

Partition size can be set in megabytes or in sectors, depending on state of **Measure in Sectors** check box;

Mark Partition as Active

Newly created partition will be set as *Active Partition*;

Assign Drive letter

For Primary Partition or Logical Drive on extended partition drive letter can be assigned from the list of available in the system drive letters;

Volume label

Text label of partition (disk). This field can be blank

File System

Select file one of the supported file systems: FAT, FAT 32 or NTFS.

Unit Allocation Size

Depending on selected file system and total partition (disk) size available allocated unit size may be different. Default value of unit size is recommended.

4. Click **Create** button to create new partition

After partition created, it should appear in **Partition Manager** available for other actions like formatting.

Change partition attributes

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

To change *logical drive* (*partition*) attributes:

1. Select volume

   In **Partition Manager**, select a *logical drive* (*partition*) node.
2. Open the Partition Attributes dialog

   - From the **Partition Manager** toolbar click **Change Attributes** button or use command **Actions** > **Change Attributes** from main menu;
   - Right-click the selected item and click **Change Attributes** from the context menu.

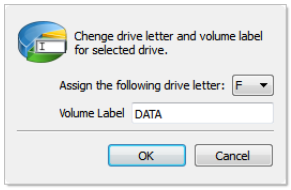


Figure 54: Create Partition dialog

   Select new drive letter from drop-down list of available drive letters and enter volume label if necessary.
3. Click **OK** to complete changes

After command is complete, volume item should appear in **Partition Manager** with new attributes.

Resize a partition or logical drive (volume)

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Existing logical drive (volume) can be extended to use unallocated space available right after that partition or shrunk to utilize unused space. To resize *Logical Drive* (*Partition*):

1. In **Partition Manager** select a *Logical Drive* (volume) node.
2. Open the **Resize Volume** dialog:

   - From the toolbar click **Resize** button or use command **Actions** > **Resize...** from main menu.
   - Right-click the selected item and click **Resize...** command from the context menu.
3. Define new partition size

   Using **Resize Volume dialog** to define new partition (volume) size

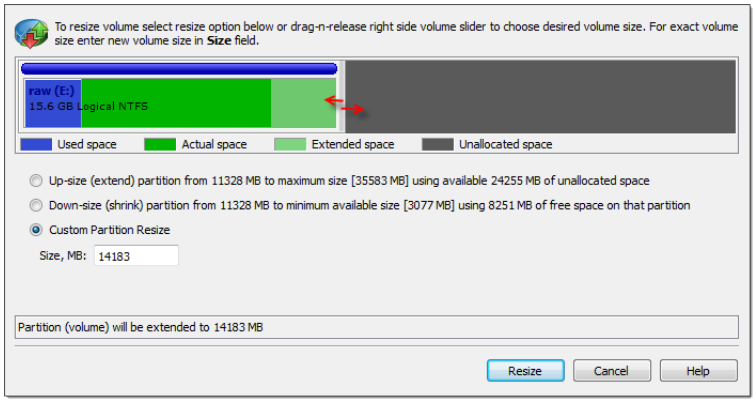

To resize volume select resize option below or drag-n-release right side volume slider to choose desired volume size. For exact volume size enter new volume size in Size field.
raw (E:)
15.6 GB Logical NTFS
Used space
Actual space
Extended space
Unallocated space
Up-size (extend) partition from 11328 MB to maximum size [35583 MB] using available 24255 MB of unallocated space
Down-size (shrink) partition from 11328 MB to minimum available size [3077 MB] using 8251 MB of free space on that partition
Custom Partition Resize
Size, MB:
14183
Partition (volume) will be extended to 14183 MB
Resize
Cancel
Help

Figure 55: Resize Volume dialog

Resize options

Use radio buttons to expand to use maximum space available or shrink to last used cluster. Use **custom** option to define exact new size of partition.

Note: Use device control drug'n'release feature to set approximate partition size.

Warning: Logical drive (volume) resize is not part of Rollback feature - all changes are final and can not be undone.

4. Click **Resize** to complete changes

Format partition

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

To format *volume* (*partition*):

1. Select volume

   In **Partition Manager** select a *Logical Drive* (Partition) node.

2. Open the Format Partition dialog

   - From the toolbar click **Format** button or use command **Actions** > **Format...** from main menu.
   - Right-click the selected item and click **Format...** command from the context menu.

3. Adjust dialog options

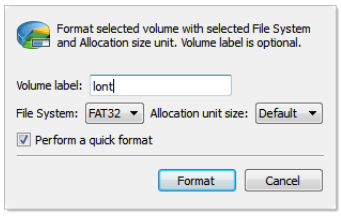


Figure 56: Format Partition dialog

Volume label

Text label of partition (disk). This field can be blank

File System

Select file one of the supported file systems: FAT, FAT 32 or NTFS.

Unit Allocation Size

Depending on selected file system and total partition (disk) size available allocated unit size may be different. **Default** value of unit size is recommended.

4. Click **Format** button to start formatting process

Danger: All data on formatting Logical Drive (partition) will be lost! Backup all your valuable data before formatting.

When formatting is complete, volume item should appear in **Partition Manager** with new attributes and file system.

Rollback partition changes

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

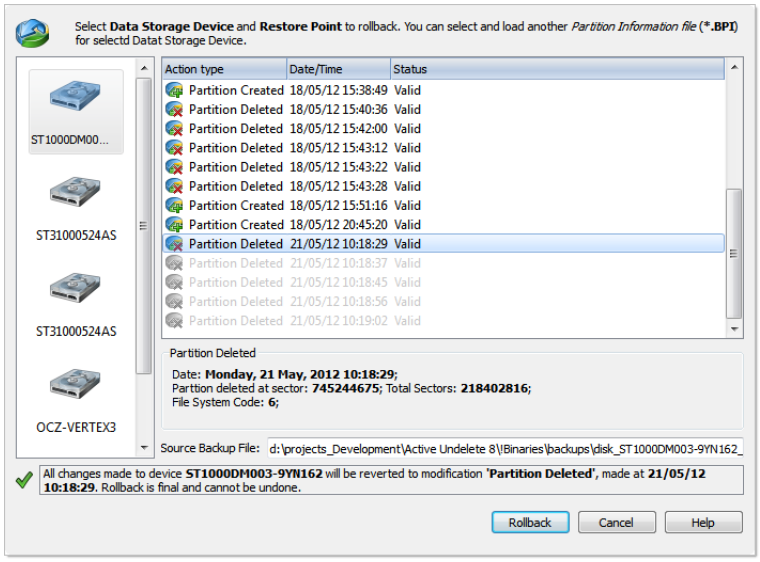
Some critical partition layout changes made to a physical device are backed up by default. Users can rollback these changes at any point by using the **Rollback Partition Changes** tool. These changes are:

- Initialize disk
- Create partition
- Format partition

- Delete partition

To open the Rollback Partition Changes dialog, do one of the following:

- From the Tools menu, choose the **Rollback Partition Changes** command.
- From the Tools tab in Command Bar, choose the Rollback Partition Changes command.
- For a selected physical device (disk) node use the context menu **Rollback Partition Changes** command.


Select Data Storage Device and Restore Point to rollback. You can select and load another Partition Information file (*.BPI) for selectd Datat Storage Device.
ST1000DM00...
ST31000524AS
ST31000524AS
OCZ-VERTEX3
Action type
Date/Time
Status
Partition Created 18/05/12 15:38:49 Valid
Partition Deleted 18/05/12 15:40:36 Valid
Partition Deleted 18/05/12 15:42:00 Valid
Partition Deleted 18/05/12 15:43:12 Valid
Partition Deleted 18/05/12 15:43:22 Valid
Partition Deleted 18/05/12 15:43:28 Valid
Partition Created 18/05/12 15:51:16 Valid
Partition Created 18/05/12 20:45:20 Valid
Partition Deleted 21/05/12 10:18:29 Valid
Partition Deleted 21/05/12 10:18:37 Valid
Partition Deleted 21/05/12 10:18:45 Valid
Partition Deleted 21/05/12 10:18:56 Valid
Partition Deleted 21/05/12 10:19:02 Valid
Partition Deleted
Date: Monday, 21 May, 2012 10:18:29;
Partition deleted at sector: 745244675; Total Sectors: 218402816;
File System Code: 6;
Source Backup File: d:\projects_Development\Active Undelete 8\!Binaries\backups\disk_ST1000DM003-9YN162_
All changes made to device ST1000DM003-9YN162 will be reverted to modification 'Partition Deleted', made at 21/05/12 10:18:29. Rollback is final and cannot be undone.
Rollback
Cancel
Help

To rollback changes made to a physical device, select a restore point in the chronologically ordered list and click the **Roll Back** button to complete the changes.

Disk editing

Disk editing in `Partition Manager` includes:

- *Edit boot sectors* on page 112
- *Edit partition table* on page 113
- *Convert MBR and GPT disks* on page 114

These features available not only from Partition Manager itself, but also from any other view that uses partition of hard drives in a same manner as in Partition Manager view.

Edit boot sectors

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Primary Boot Sector and *Copy Boot Sector* (if applicable) can be edited and **synchronized by** individual fields. `Active@ UNDELETE` provide "suggested" boot sector with most appropriate values for reference.

To Edit (synchronize) boot sectors:

1. Select logical drive (partition)

   In **Partition Manager** or **Recovery Explorer** select a *logical drive* (*partition*) node.
2. Open the **Edit Boot Sectors** dialog
   - From the toolbar click **Edit Boot Records** button or use command **Actions** > **Edit Boot Records...** from main menu;
   - Right-click the selected item and click **Edit Boot Records...** command from the context menu.
3. Edit boot sectors

   Use radio buttons near the value fields to select and click **OK** button to confirm changes.

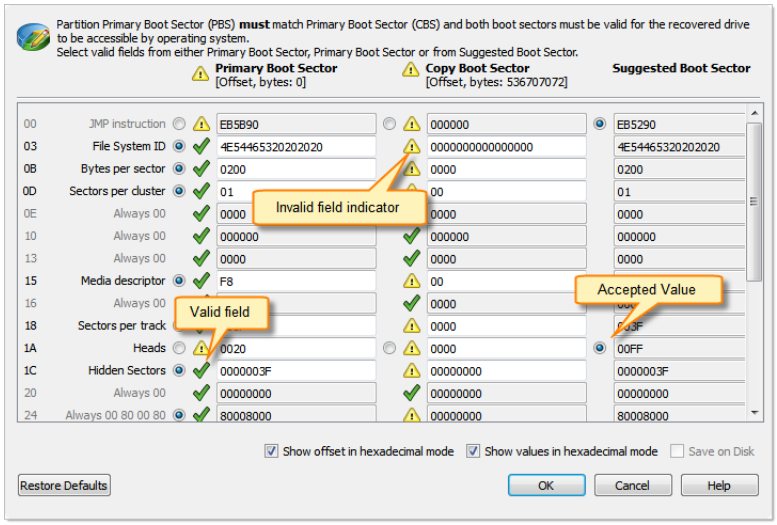

Partition Primary Boot Sector (PBS) must match Primary Boot Sector (CBS) and both boot sectors must be valid for the recovered drive to be accessible by operating system.
Select valid fields from either Primary Boot Sector, Primary Boot Sector or from Suggested Boot Sector.
Primary Boot Sector [Offset, bytes: 0]
Copy Boot Sector [Offset, bytes: 536707072]
Suggested Boot Sector
Invalid field indicator
Valid field
Accepted Value
Show offset in hexadecimal mode
Show values in hexadecimal mode
Save on Disk
Restore Defaults
OK
Cancel
Help

Figure 57: Synchronize Boot sectors dialog box

4. Click **OK** to complete changes

Edit partition table

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

You can edit *Disk system records* (MFT, Boot sector etc.) by using specially designed forms.

To edit *partition table*:

1. In **Recovery Explorer** or in **Partition Manager** select a *physical device*
2. Open the **Edit Partition Table** dialog:
   - Use command **Actions** > **Partition Table...** from main menu;
   - Right-click the selected item and click **Partition Table** command from the context menu.
3. Change desired fields to appropriate values

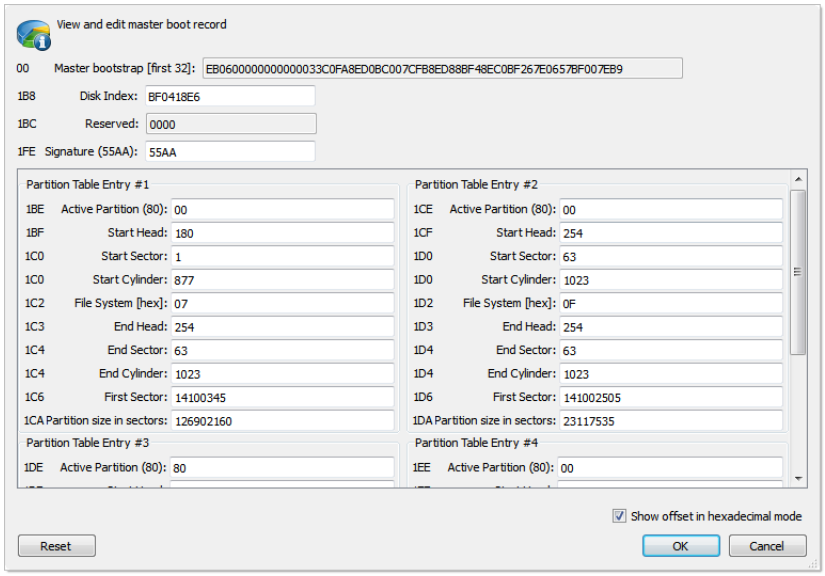


Figure 58: Edit Partition Table dialog

- To discard all changes and restore all values to fields in the dialog, click **Reset**.
- To save all changes made in the dialog, click **Save**.

Warning:

Saving incorrect values might render the partition useless. You may not undo changes that you make in this dialog.

4. Click **OK** to complete changes

Convert MBR and GPT disks

For freshly initialized (empty) physical disk partition style can be changed at any time from *MBR* to *GPT* or from *GPT* to *MBR*.

To convert partition style:

1. Select disk in Partition Manager
2. Change partition style
   - Use **Actions** > **Convert to MBR [GPT]** command from main menu or
   - Use **Convert to MBR [GPT]** command from context menu

If conversion is successful, then device partitioning will be changed and property label will indicate new attribute.

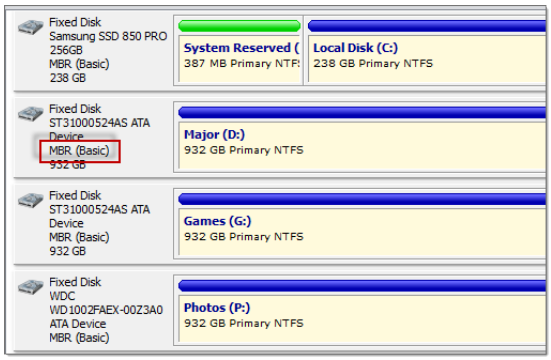


Figure 59: Disk partitioning style

File Organizer

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

Feature overview

`File Organizer` is advanced feature designed to group and rename files, using their system attributes or meta attributes, before actual recovery.

Every file has *system attributes* like date (Accessed, Created and Modified), file type (defined by extension) and associated with that file type registered application. These attributes can be used to generate new file name or folder (group) for every file with the same attribute. In addition to system attributes some files, mostly media or images may contain meta fields such as artist name, title, album name and others. `File Organizer` also use these meta fields to group files in a folder with same attribute. Thus, `File Organizer` operates *file organizing rules* which defines folder grouping hierarchy and file renaming rules.

This feature presented in two ways:

Toolbar control

Drop-down menu in file manipulated views, such as scan results, for easy file grouping and renaming.

Tabbed tool view

Specially designed tool view where files can be collected from different sources and organized, renamed or regrouped, before batch recovery to safe location.

Customize file organizing rules

In addition to predefined *file organizing rules*, user can define **custom** file grouping and renaming rules and use them in a same manner as predefined. To create or edit custom file organizing rule select **Organize Files** > **Customize** command in view's toolbar where `File Organizer` is used. for more detail, read: *Create custom file organizing rule* on page 117.

User-defined (custom) rules once created in any view becomes available in all other views ready to use.

Renaming files

Names of files can also be changed (optional) by *file organizing rule* using *file name pattern*, applicable for every processing file or by individually applied *file name pattern*, depending on file type. For more information read *File renaming patterns by file type* on page 118.

Important: Changing file names **does not affect actual files** on disk - its only "virtual" file name changes.

Organize files in a view

`Organize Files` feature is used to group files by their attributes or renaming them by using name pattern in `File Recovery wizards` and in all views of Active @ UNDELETE that manipulates files:

- *Work with logical drive scan results* on page 16
- *Work with device scan results* on page 19
- *Search results view* on page 42

For *files detected by their signatures* `Organize Files` feature could be very useful for applying meaningful name for every file and grouping them in folders with names generated based on file's meta tags and attributes.

To apply *file organizing rule* simply select it from drop-down **Organize Files** menu. *File organizing rule* can be also applied on folder or a group from context menu.

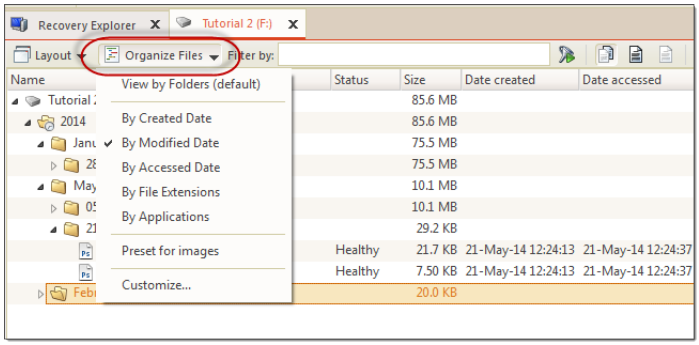


Figure 60: File Organizer menu

Files in presented view can be organized by applying grouping and renaming rule. There are several predefined rules ready to use:

- By Created Date
- By Modified Date
- By Accessed Date
- By File Extensions
- By Associated Application

File organizing rule can be applied for all files presented in current view or for specific file folder or file group. To apply *file organizing rule* for all files in a view use toolbar drop-down button **Organize Files** and to apply rule for a folder or a file group - use context menu command **Organize**.

In addition to predefined organizing rules user can create their own rules, preserved between sessions, by clicking **Organize Files** > **Customize...** drop down menu from view's toolbar. Read *Create custom file organizing rule* on page 117 article for details.

File Organizer view

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

`File Organizer` is utility view that helps to organize files (regroup and/or rename) using their system or meta attributes from different sources (for instance scan and search results) to recover them all at once to selected location.

To add files to `File Organizer view`:

1. Select files or folders in scan result view;
2. In context menu select **Add to File Organizer** command;

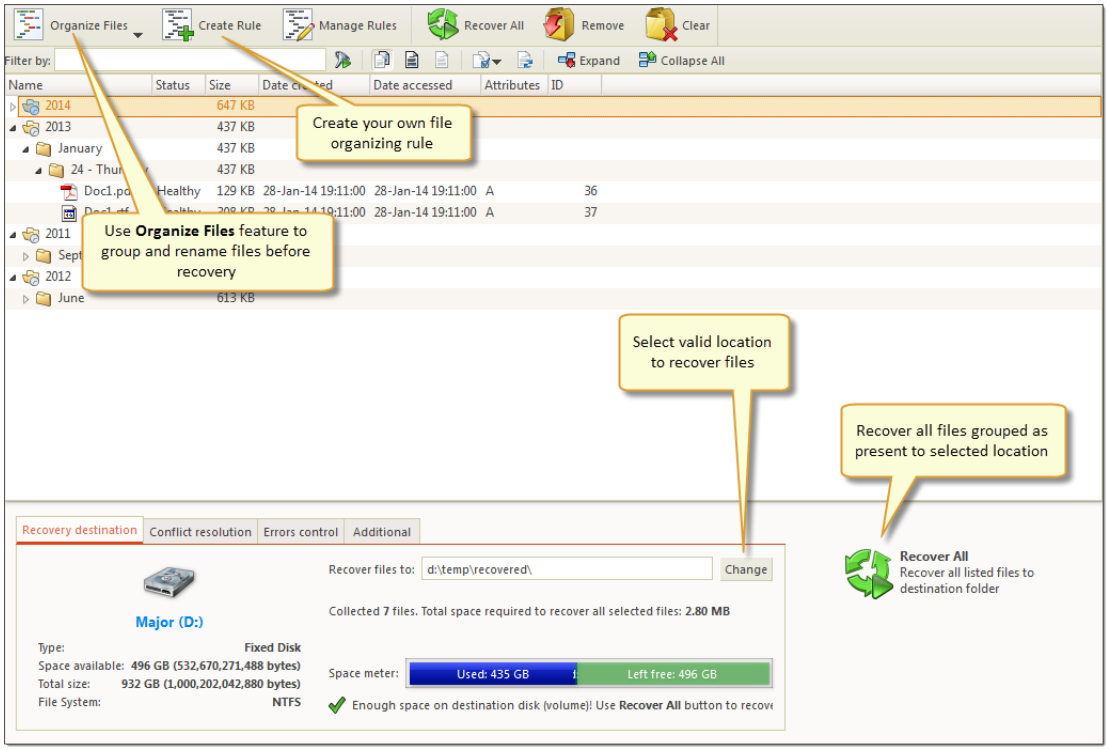


Figure 61: File Organizer view

All selected files will be added to File Organizer, excluding duplicates. You can repeat commands above and add files from different sources.

In `File Organizer view` you can remove unwanted files by selecting them and then click **Remove** button in toolbar or click **Clear** button in toolbar to remove files from `File Organizer view`. Use `File Organizer` feature to group o rename files before recovery.

`File Organizer` is advanced tool designed to group and rename files, using their system attributes or meta attributes, before actual recovery. Click on **Organize Files** drop down menu and select one of the predefined *file organizing rules* to group files in a view:

- By Created Date
- By Modified Date
- By Accessed Date
- By File Extension
- By Application

Select **Organize Files** > **Customize** command to create and apply custom file organizing rule. Read *Create custom file organizing rule* on page 117 for more information.

When all files grouped and renamed as desired, select location to recover files and change default options if necessary. Click **Recover All** button in right bottom corner or click **Recover All** button in toolbar to recover all files from `File Organizer view` to one location.

Create custom file organizing rule

Active @ UNDELETE can use custom file organizing rules to group or\and rename files before recovery.

In addition to predefined file organizing rules user can create custom rules in **File Organizer dialog** and either apply (run) it immediately or use from context menu.

1. Open **File Organizer dialog**

   Click **Organize Files** > **Customize** command in view's toolbar where `File Organizer` is used.

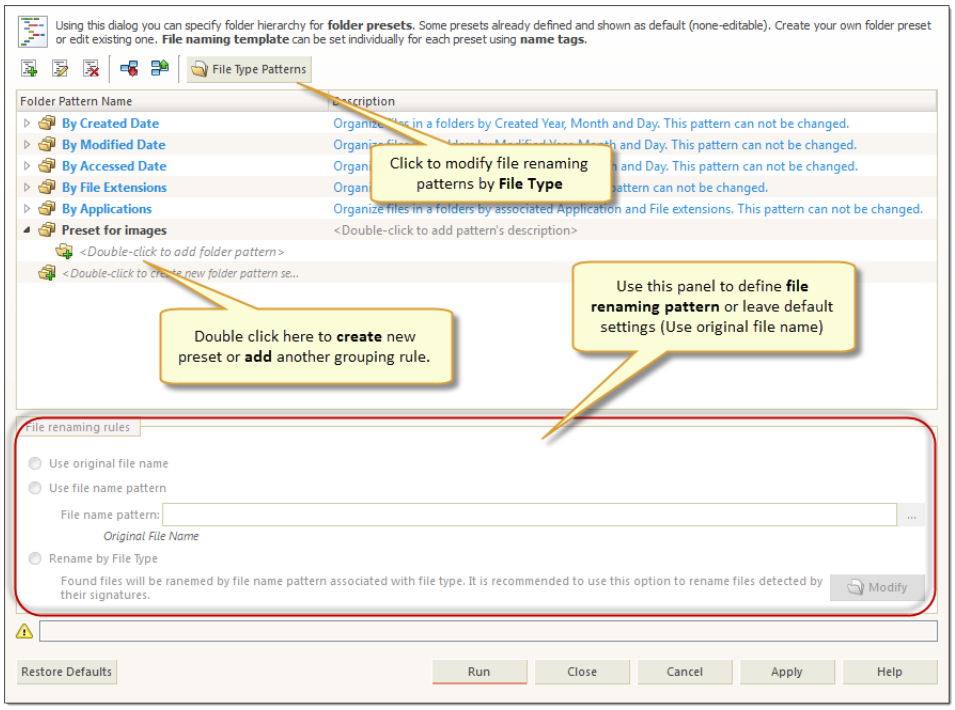

Using this dialog you can specify folder hierarchy for folder presets. Some presets already defined and shown as default (none-editable). Create your own folder preset or edit existing one. File naming template can be set individually for each preset using name tags.
File Type Patterns
Folder Pattern Name
Description
By Created Date
By Modified Date
By Accessed Date
By File Extensions
By Applications
Preset for images
<Double-click to add folder pattern>
<Double-click to add pattern's description>
Click to modify file renaming patterns by File Type
Double click here to create new preset or add another grouping rule.
Use this panel to define file renaming pattern or leave default settings (Use original file name)
File renaming rules
Use original file name
Use file name pattern
File name pattern:
Original File Name
Rename by File Type
Found files will be ranemed by file name pattern associated with file type. It is recommended to use this option to rename files detected by their signatures.
Modify
Restore Defaults
Run
Close
Cancel
Apply
Help

Figure 62: File Organizer dialog

Caption

Assign text label for virtual disk to recognize in Recovery Explorer. Optional.

File renaming rules

User can decide to leave files as-is (default value) or rename every one of them by using file name pattern (see: *File attributes and meta tags* on page 119) or choose to rename every file by file name pattern associated with file type (see: *File renaming patterns by file type* on page 118).

First and last sector

Select virtual disk boundaries, by default - entire original physical disk is used.

2. Create new file organizing rule by
   - Double click on gray item labeled *<Double-click to create new folder rule>* at the bottom of rule list
   - or click **Add new rule** button in dialog's toolbar;
3. Add folder patterns

Double click on child elements in edited rules to open drop-down control with folder pattern choices. Each following folder pattern depends on previous choice. E.g. if media file pattern selected then all following pattern choices will be relevant to media files. See *File attributes and meta tags* on page 119 for more info.

4. Set file rename rule (optional) by selecting one of the option:
   - Leave default **Use original file name** option selected to skip file renaming;
   - Select **Use file name pattern** and enter file name pattern to rename all files in rule or
   - Select **Rename by File Type** option to rename all files in rule by renaming patterns associated with supported file types. See *File renaming patterns by file type* on page 118 for details.
5. Confirm and apply changes

   Click **Run** button to apply and execute selected rule or click **Apply** button to save changes.

After rule is created, it will be automatically added to drop-down **Organize Files** menu in all related views and appear in context menu for file folders or file groups.

Note: Using file **meta attributes** for grouping or renaming may seriously impact file organizing performance.

File renaming patterns by file type

By applying *file organizing rule* applicable files can be renamed by using *file name pattern* specific to each supported File Type. In **File Name Patterns** dialog user can review and modify these patterns if necessary.

1. Open **File Organizer dialog**

   To modify file renaming patters for specific file time open **File Organizer dialog** first. Click **Organize Files** > **Customize** command in view's toolbar where `File Organizer` is used.

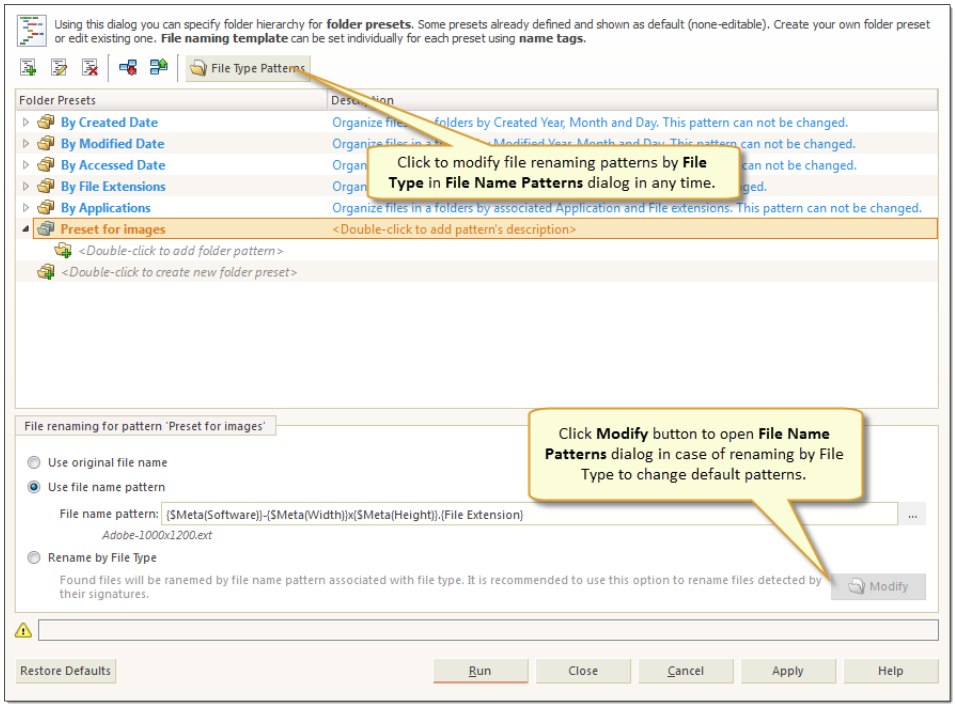

Using this dialog you can specify folder hierarchy for folder presets. Some presets already defined and shown as default (none-editable). Create your own folder preset or edit existing one. File naming template can be set individually for each preset using name tags.
File Type Patterns
Folder Presets
By Created Date
By Modified Date
By Accessed Date
By File Extensions
By Applications
Preset for images
<Double-click to add folder pattern>
<Double-click to create new folder preset>
Click to modify file renaming patterns by File Type in File Name Patterns dialog in any time.
File renaming for pattern 'Preset for images'
Use original file name
Use file name pattern
File name pattern:
{$Meta(Software)}-{$Meta(Width)}x{$Meta(Height)}.{File Extension}
Adobe-1000x1200.ext
Rename by File Type
Found files will be ranemed by file name pattern associated with file type. It is recommended to use this option to rename files detected by their signatures.
Modify
Click Modify button to open File Name Patterns dialog in case of renaming by File Type to change default patterns.
Restore Defaults
Run
Close
Cancel
Apply
Help

Figure 63: File Organizer dialog

2. Open **File Name Patterns dialog**

   To open **File Name Patterns** dialog click **File Type Patterns** button or in case of **Rename by File Type** option selected - click **Modify** button for a same result.
3. Change file name patterns

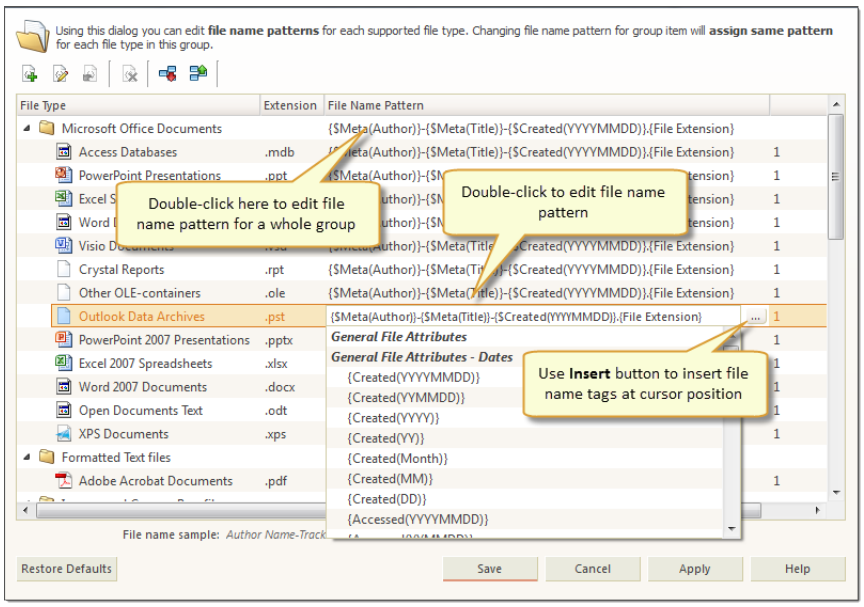

Using this dialog you can edit file name patterns for each supported file type. Changing file name pattern for group item will assign same pattern for each file type in this group.
File Type
Extension
File Name Pattern
Microsoft Office Documents
Access Databases
PowerPoint Presentations
Crystal Reports
Other OLE-containers
Outlook Data Archives
PowerPoint 2007 Presentations
Excel 2007 Spreadsheets
Word 2007 Documents
Open Documents Text
XPS Documents
Formatted Text files
Adobe Acrobat Documents
Double-click here to edit file name pattern for a whole group
Double-click to edit file name pattern
Use Insert button to insert file name tags at cursor position
General File Attributes
General File Attributes - Dates
File name sample:
Restore Defaults
Save
Cancel
Apply
Help

Figure 64: File Name Patterns dialog

In **File Name Patterns dialog** you can change file name pattern for each file type by double clicking on file name pattern field for desired file type or click **Edit** button in toolbar for same result. Click **Reset** button in toolbar to reset file name pattern for selected file type to defaults or click **Restore Defaults** to reset all file name patterns to their default values.

You can edit file name patterns for every file in a group at once by editing group pattern.

4. Add User File Type pattern

   User can add custom file type pattern to existing list by clicking **Add** button in dialogs toolbar and completed required fields: file type (either type it in or select from drop down list) and providing file name pattern using **Insert** button to insert file name tags at current cursor position.

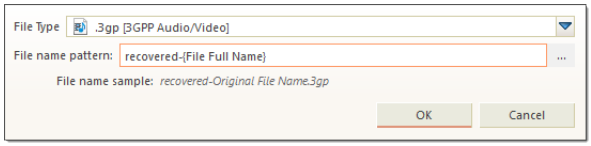


Figure 65:

> **Important:** Due to not supporting meta tag analysis for user defined file types, only system attributes available for name patterns

5. Confirm changes

   Click **Apply** to preserve intermediate changes or click **Save** button to save and close dialog.

File attributes and meta tags

File organizing rule uses pattern tags that represents single (or several) values retrieved as file or meta attribute from file.

Folder pattern tags

Folder pattern tags are used to define file's grouping in folders by same file system or meta attributes. Each following folder pattern depends on previous choice. E.g. if media file pattern selected then all following pattern choices will be relevant to media files.

File Extensions

Collects all files with a same file type (file extension);

Associated Application

Collects all files assigned to the same default application;

Created Date - Year

Full year of date when file was created, for example: 2014;

Modified Date - Year

Full year of date when file was modified, for example: 2014;

Accessed Date - Year

Full year of date when file was last accessed, for example: 2014;

Note: Each date attribute can be additionally structured with attributes: **Month**, **Day**, **Weekday**.

Artist

Artist name

Album

Album name

Genre

Genre literal name

Date Taken (YYYY-MM-DD)

Full date when picture was taken, for example: **2014-05-23**;

Date Taken (YYYY)

Full year of date when picture was taken, for example: **2014**;

Make

Literal transcription of genre code.

Model

Literal transcription of genre code.

Note: Date Taken (YYYY) can be additionally structured with attributes: **Date Taken (Month)**, **Date Taken (DD)**, **Date Taken (DD - Weekday)**.

Author

Full year, for example: 2014;

Date Created (YYYY)

Short year, for example: **2014**;

Date Last Saved (YYYY)

Short year, for example: 14;

Date Month-Day

Literal transcription of genre code.

Note: Each date attribute can be additionally structured with attribute: **Date Month-Day**.

File name tags

File name tags are used to defile file renaming pattern. File name editor allows insert tags at cursor position and present name tags organized in groups:

{File Full Name}

Full file name, including file suffix and extension;

{File Base Name}
Full file name without extension;
{File Extension}
File extension without leading dot;
{Sequence #}
Sequential enumerator, without leading zero, for example: **89**;
{Sequence 00#}
Three digit sequential enumerator, with leading zero, for example: **089**;
{Sequence 000#}
Four digit sequential enumerator, with leading zero, for example: **0089**;
{Created}
Created date. *See below for specific Date Formats*;
{Accessed}
Accessed date. *See below for specific Date Formats*;
{Modified}
Modified date. *See below for specific Date Formats*;
{Year}
Full year of release, for example: **2014**;
{Album}
Name of an album;
{Title}
Composition's title;
{Artist}
Full year, for example: **2014**;
{Track #}
Number of track;
{Genre}
Literal transcription of genre code;
{Make}
Camera manufacturer name, for example: **Nikon** or **Canon**;
{Model}
Camera model name, for example: **Canon EOS M**;
{Software}
Application name that was used to process (export) image file;
{Date Taken}
Full date when image was taken. *See below for specific Date Formats*;
{Width}
Horizontal dimension of an image;
{Height}
Vertical dimension of an image;
{Author}
Document's author name;
{Title}
Document's Title (if any);

{Created Date}

Date when document was created. *See below for specific Date Formats*;

{Saved Date}

Date when document was last saved. *See below for specific Date Formats*;

Date formats

Each date tag can be presented in any of following format:

{YYYY-MM-DD}

Full date, for example: **2014-05-23**;

{YYYY}

Full year, for example: **2014**;

{YY}

Short year, for example: **14**;

{MM}

Month short form, for example: **11** for November;

{Month}

Month literal form, for example: **November**;

{DD}

Day of a month, for example: **23**;

Forensic Report

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

`Forensic Report` is an advanced tool designed to collect files based on local user activity time frames. Files can be collected by the following date types:

- By created date
- By modified date
- By accessed date

When `Forensic Report` view opens, it will automatically parse local Windows Log records to collect information about user sessions. Each following Forensic Scan will group files under corresponding user session time frame.

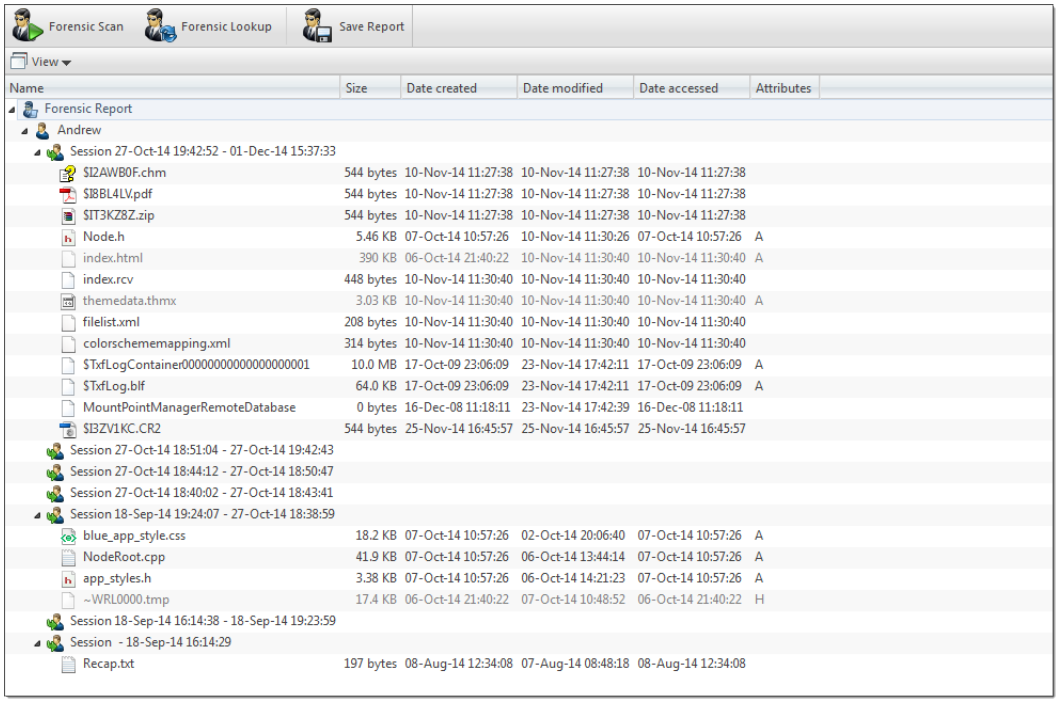


Figure 66: Forensic investigation results

Scan logical drives (volumes) to complete Forensic Report.

Forensic Scan

Use this command to investigate local volumes. See *Investigate volumes* on page 123 for details.

Forensic Lookup

Use this command to re-populate local Windows Event Log. After log parsing completes, all previous volume scans will be analyzed again and the results will be shown in Forensic Report view.

Save Report

Use **Save Report** command to save your findings to a text file. From the context menu, detected files can be inspected, opened in Disk Editor, previewed, and more.

Investigate volumes

During the scan all deleted and existing files will that match defined criteria will be collected and grouped by User Sessions. The results (report) of a logical drive scan are displayed in a separate tabbed view. To create forensic report of a logical drive(s):

1. Open Forensic Report tool
   - From the Command bar click **Tools** tab and then **Forensic Report** button.
   - From main menu click **Tools** > **Forensic Report**command.
2. Open the Investigate volumes dialog box
   - Click the **Forensic Scan** button from the view's toolbar.

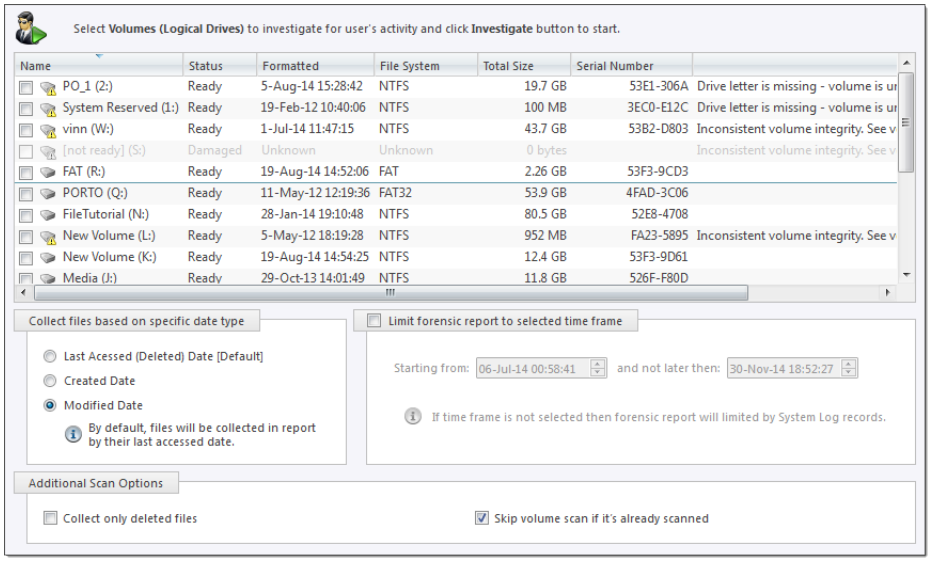

Select Volumes (Logical Drives) to investigate for user's activity and click Investigate button to start.
Name
Status
Formatted
File System
Total Size
Serial Number
PO_1 (2:) Ready 5-Aug-14 15:28:42 NTFS 19.7 GB 53E1-306A Drive letter is missing - volume is ur
System Reserved (1:) Ready 19-Feb-12 10:40:06 NTFS 100 MB 3EC0-E12C Drive letter is missing - volume is ur
vinn (W:) Ready 1-Jul-14 11:47:15 NTFS 43.7 GB 53B2-D803 Inconsistent volume integrity. See v
[not ready] (S:) Damaged Unknown Unknown 0 bytes Inconsistent volume integrity. See v
FAT (R:) Ready 19-Aug-14 14:52:06 FAT 2.26 GB 53F3-9CD3
PORTO (Q:) Ready 11-May-12 12:19:36 FAT32 53.9 GB 4FAD-3C06
FileTutorial (N:) Ready 28-Jan-14 19:10:48 NTFS 80.5 GB 52E8-4708
New Volume (L:) Ready 5-May-12 18:19:28 NTFS 952 MB FA23-5895 Inconsistent volume integrity. See v
New Volume (K:) Ready 19-Aug-14 14:54:25 NTFS 12.4 GB 53F3-9D61
Media (J:) Ready 29-Oct-13 14:01:49 NTFS 11.8 GB 526F-F80D
Collect files based on specific date type
Last Acessed (Deleted) Date [Default]
Created Date
Modified Date
By default, files will be collected in report by their last accessed date.
Limit forensic report to selected time frame
Starting from: 06-Jul-14 00:58:41
and not later then: 30-Nov-14 18:52:27
If time frame is not selected then forensic report will limited by System Log records.
Additional Scan Options
Collect only deleted files
Skip volume scan if it's already scanned

Figure 67: Scan volumes dialog

Date type

Additional drives can be selected to be scanned on the **Logical Drives** list. These will be scanned simultaneously.

Date range

Files can be collected by the following date types:

- By Created Date
- By Modified Date
- By Accessed Date

Skip scanned volumes

Use this option to ignore already scanned volumes.

Collect deleted files only

Use this option to collect only deleted files in final report.

Click **Investigate** to initiate scans of selected logical drives (volumes) and analyze scan result based on users' activity.

3. Scan selected volumes

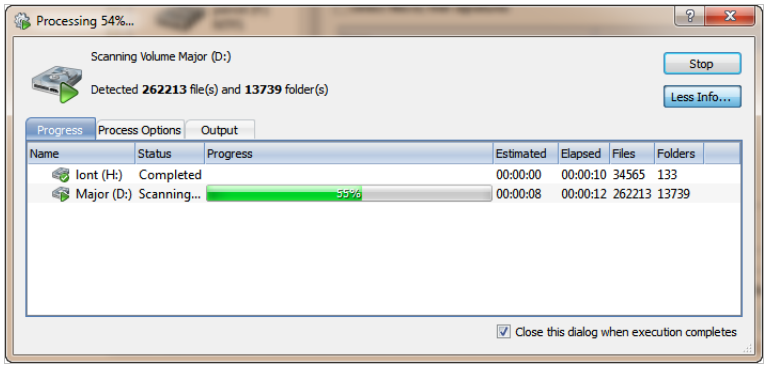


Figure 68: Scan in progress

During the scan:

- To display or hide scanning events and progress details toggle **More\Less Info** button at any time.

- To terminate the scan process, click **Stop** at any time. Results may be not accurate or complete.

4. Review scan results

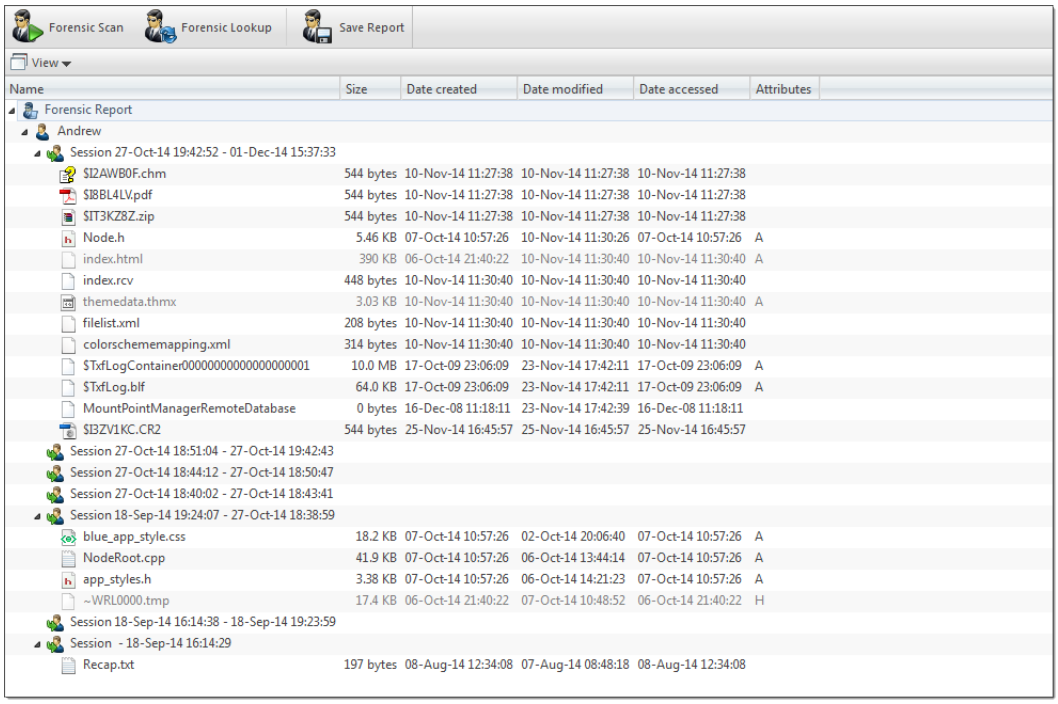


Figure 69: Volume scan result view

5. Save Forensic report (optional)

   Final reports can be stored in a plain text file that contains lists of detected files grouped by user sessions, detailed information about scanned drives, and other user activities from Windows Event Log.

Appendix

Searching patterns

Wildcards

A *wildcard* is a character that can be used as a substitute for any of a class of characters in a search. Wildcard characters are often used in place of one or more characters when you do not know what the real character is or you do not want to enter the entire name. In Active@ UNDELETE three types of wildcard are used: **star** or asterisk(*****), **question mark** (?) and **number sign** (#).

Examples of using wildcards:

Wildcard character	Example	Description
Asterisk (*)	docum*	Use the asterisk as a substitute for zero or more characters if you are looking for a file that you know what it starts with and you cannot remember the rest of the file name. The example locates all files of any file type that begin with **"docum"** including *documents.txt*, *document_01.doc* and *documentum.doc*.
	docum*.doc	To narrow the search to a specific type of file, include the file extension. The example locates all files that begin with **"docum"** and have the file name extension **.doc**, such as *document_01.doc* and *documentum.doc*.
Question mark (?)	doc?.doc	Use the question mark as a substitute for a single character in a file name. In the example, you will locate the file *docs.doc* or *doc1.doc* but not *documents.doc*.
Number sign (#)	doc_###.doc	Use the number sign (also known as the pound or hash sign) as a substitute for a single number in a name. In the example, you will locate the file *doc_012.doc* or *doc_211.doc* but not *doc_ABS.doc*.

Regular expressions

Regular expressions are special search patterns, more capable then wildcards to define search criteria.

Examples of using regular expressions:

^\d\d?$ - match integers 0 to 99

^\S+$ - match strings without white space

\b(mail|letter|correspondence)\b - match strings containing 'mail' or 'letter' or 'correspondence' but only match whole words i.e. not 'email'

&(?!amp;) - match ampersands but not &

\b(Eric|Eirik)\b - match Eric or Eirik

Application log

This log view monitors each action taken by the application and displays messages, notifications and other service information. Use the messages in this screen to observe and further understand the flow of the recovery process.

To open and activate Application log view do one of the following:

- From main menu choose **View** > **Application Log** or
- Use **F8** keyboard shortcut at any time

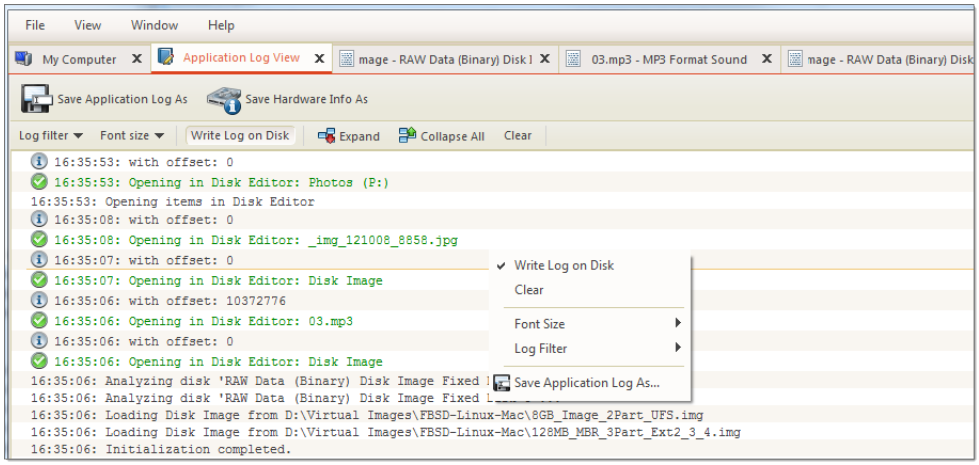

File
View
Window
Help
My Computer
Application Log View
mage - RAW Data (Binary) Disk I
03.mp3 - MP3 Format Sound
mage - RAW Data (Binary) Disk
Save Application Log As
Save Hardware Info As
Log filter
Font size
Write Log on Disk
Expand
Collapse All
Clear
16:35:53: with offset: 0
16:35:53: Opening in Disk Editor: Photos (P:)
16:35:53: Opening items in Disk Editor
16:35:08: with offset: 0
16:35:08: Opening in Disk Editor: _img_121008_8858.jpg
16:35:07: with offset: 0
16:35:07: Opening in Disk Editor: Disk Image
16:35:06: with offset: 10372776
16:35:06: Opening in Disk Editor: 03.mp3
16:35:06: with offset: 0
16:35:06: Opening in Disk Editor: Disk Image
16:35:06: Analyzing disk 'RAW Data (Binary) Disk Image Fixed
16:35:06: Analyzing disk 'RAW Data (Binary) Disk Image Fixed
16:35:06: Loading Disk Image from D:\Virtual Images\FBSD-Linux-Mac\8GB_Image_2Part_UFS.img
16:35:06: Loading Disk Image from D:\Virtual Images\FBSD-Linux-Mac\128MB_MBR_3Part_Ext2_3_4.img
16:35:06: Initialization completed.
Write Log on Disk
Clear
Font Size
Log Filter
Save Application Log As...

Figure 70: Application log view

To prepare a log file, turn on **Display Trace Events** and **Write Log on Disk** options in the *Application preferences* on page 130 dialog.

It is best to save the log file to a physical disk that is different from the disk that holds the deleted data. By doing this, you reduce the risk of writing over the data that you are trying to recover.

Log filter

Show or hide specific entry types in log view:

Show warning entries

Show non-critical warning entries

Show advanced entries

Show advanced entries related to application behaviour and data analysis

Show console entries

Duplicate console entries into main log view

Show system entries

Show entries related to operating system activity and state

Font size

Change size of mono-space font used in log view for better experience

Write log on Disk

Writes log entries in dedicated file on disk, located in application directory. **Off** by default.

Expand and Collapse

Expand or collapse all log entries respectively

Clear

Clear log for current application sessions

Tip: We recommend that you attach a copy of the log file to all requests made to our technical support group. The entries in this file will help us resolve certain issues.

Console view

Additional log view (pane) to show log entries related to active feature view to display active process (e.g. file recover or disk scan) entries and urgent (critical) messages.

Property views

Selected item properties

To show detailed information about any subject of an application, such as disk, partition, volume, file etc use information views. In general, when open it follows selection changes and show information about selected item automatically. Besides only displaying valuable data it also allows to copy that information into clipboard by using context menu commands.

Copy Value

copy only value of selected field in the information view

Copy Field

Copy formatted name and value field pair

Copy All

Copy all information as formatted set of name and value pairs.

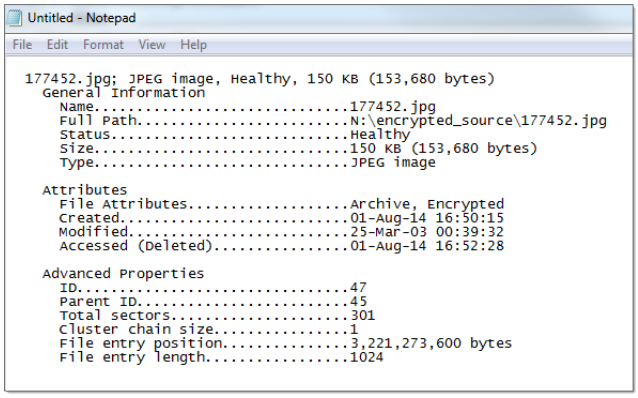


Figure 71: Example of copied information about file

Property view

To show property view for selected item do one of the following:

- Click **View** > **Windows** > **Properties**
- Click **F4** keyboard short cut or
- Use context menu command **Properties** for the same effect

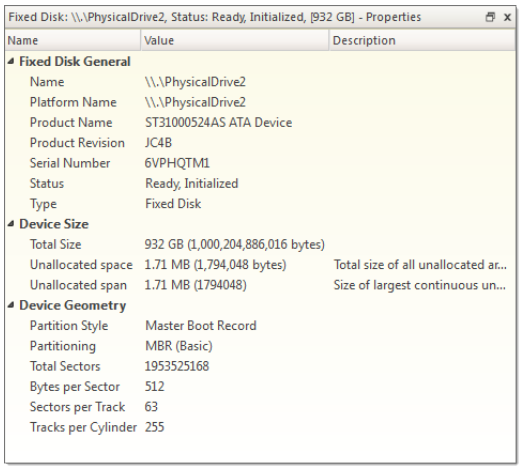

Fixed Disk: \\.\PhysicalDrive2, Status: Ready, Initialized, [932 GB] - Properties
Name
Value
Description
Fixed Disk General
Name \\.\PhysicalDrive2
Platform Name \\.\PhysicalDrive2
Product Name ST31000524AS ATA Device
Product Revision JC4B
Serial Number 6VPHQTM1
Status Ready, Initialized
Type Fixed Disk
Device Size
Total Size 932 GB (1,000,204,886,016 bytes)
Unallocated space 1.71 MB (1,794,048 bytes) Total size of all unallocated ar...
Unallocated span 1.71 MB (1794048) Size of largest continuous un...
Device Geometry
Partition Style Master Boot Record
Partitioning MBR (Basic)
Total Sectors 1953525168
Bytes per Sector 512
Sectors per Track 63
Tracks per Cylinder 255

Figure 72: Property view example

S.M.A.R.T. Information

Another information view that displays SMART (Self-Monitoring, Analysis and Reporting Technology) data of selected hard drive, if supported. To show this view:

- Click **View** > **Windows** > **SMART Info**
- Use context menu command **SMART Info** for the same effect

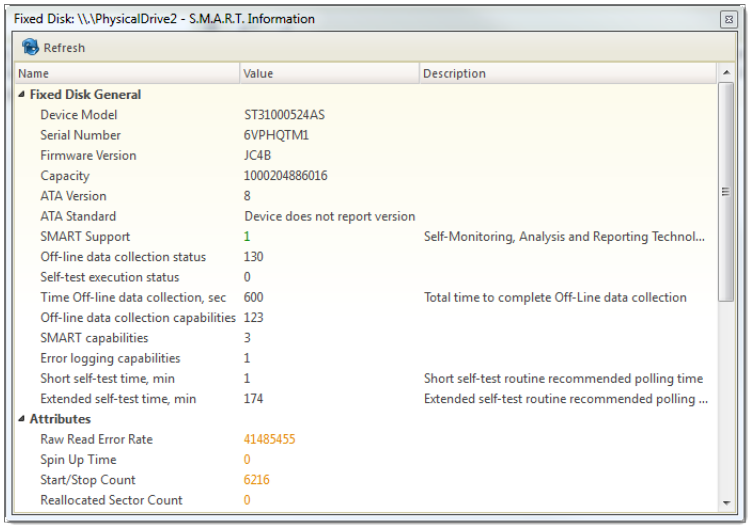


Figure 73: SMART information for physical device example

Hardware diagnostic file

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

If you want to contact our technical support staff for help with file recovery, a file that contains a summary of your local devices is helpful. `Active@ UNDELETE` allows you to create a summary listing file in XML format. This data format is “human-readable” and can help our technical support staff analyze your computer configuration or point out disk failures.

To create a hardware diagnostic file from the **File** menu, click **Save Hardware Info As...** command.

Note: To save time when contacting our technical support staff, we highly recommend that you provide us with a hardware diagnostic file.

Application preferences

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

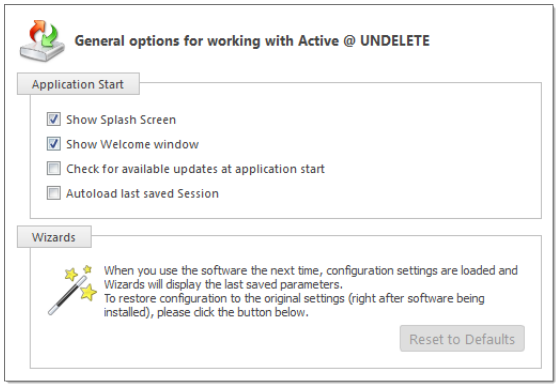
You can change many of the settings that affect the application's behavior in the **Preferences dialog**.

To open the Preferences dialog, do one of the following:

- From the **Tools** menu, select **Preferences**.
- In the **Application Command** bar select **Support** tab, click **Preferences**.
- Press **F10** keyboard key.

See description of each tabbed preferences page below

General settings


General options for working with Active @ UNDELETE
Application Start
Show Splash Screen
Show Welcome window
Check for available updates at application start
Autoload last saved Session
Wizards
When you use the software the next time, configuration settings are loaded and Wizards will display the last saved parameters.
To restore configuration to the original settings (right after software being installed), please click the button below.
Reset to Defaults

Show splash screen

Enable\Disable splash screen at application start.

Show Welcome window

Show\Hide welcome dialog at application start.

Check for available updates at application start

Each time when Active@ UNDELETE starts it will request for available update\upgrade and prompt for download if newer version is available for download.

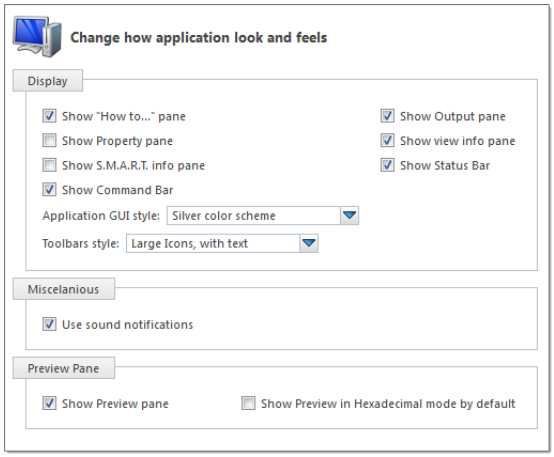
Auto load last saved session

When this option is on, at application start Active@ UNDELETE will load latest saved session state, such as environment configuration, opened *Disk Images* and *Scan Results*. See *Using scan results* on page 33

Reset wizards to default

Restores original wizard settings and page sequence to default state.

Environment options



Show "How to..." pane

Show\Hide left side context help panel. Context help will automatically changed when active view (tab) is changed to show related hints and brief description of every view.

Show Property pane

Show\Hide selected item property pane.

Show S.M.A.R.T. pane

Show\Hide SMART information pane for selected physical device. Displayed only for SMART compatible devices.

Show command bar

Show\Hide right side command bar that contains shortcuts to most usable commands and actions.

Show Output pane

Show\Hide output (console) pane — simplified version of Application Log view.

Show view info pane

Show\Hide property pane contains attribute and properties for current view, e.g. search criteria for search result view.

Show Status bar

Show\Hide application status bar

GUI style

Switch global look-n-feel application style.

Toolbar style

Toggles toolbar icon and text styling.

Use sound

Enable\Disable application sound notifications.

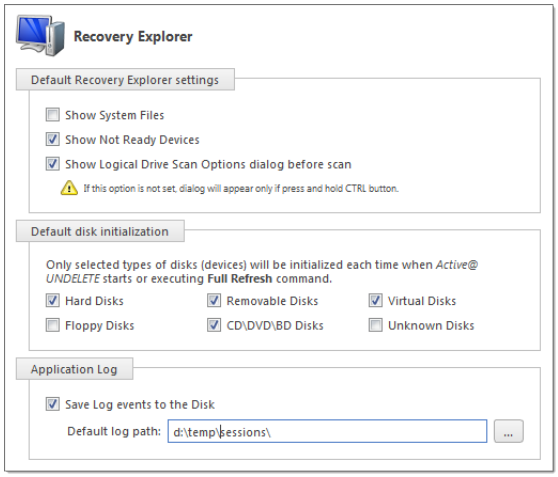
Show preview pane

Show file preview pane by default

Show preview pane in hexadecimal mode

When this option is on, file preview by default will be always shown in hexadecimal mode without any attempt to load it as an image or a document.

Recovery Explorer options


Recovery Explorer
Default Recovery Explorer settings
Show System Files
Show Not Ready Devices
Show Logical Drive Scan Options dialog before scan
If this option is not set, dialog will appear only if press and hold CTRL button.
Default disk initialization
Only selected types of disks (devices) will be initialized each time when Active@ UNDELETE starts or executing Full Refresh command.
Hard Disks
Removable Disks
Virtual Disks
Floppy Disks
CD\DVD\BD Disks
Unknown Disks
Application Log
Save Log events to the Disk
Default log path:
d:\temp\sessions\
...

Show system files

Show\Hide system files in Recovery explorer. In most of the cases these files are not recoverable.

Show no ready devices

Show\Hide devices that has not read state and can not be scanned.

Show Logical Drive scan dialog by default

When this option is OFF, double click logical drive (volume) node in Recover Explorer view will initiate scan with default (most usable) options. Only when CTRL button is pressed down at the same time or this option is off, Scan Volume dialog will appear and let you to change scan options.

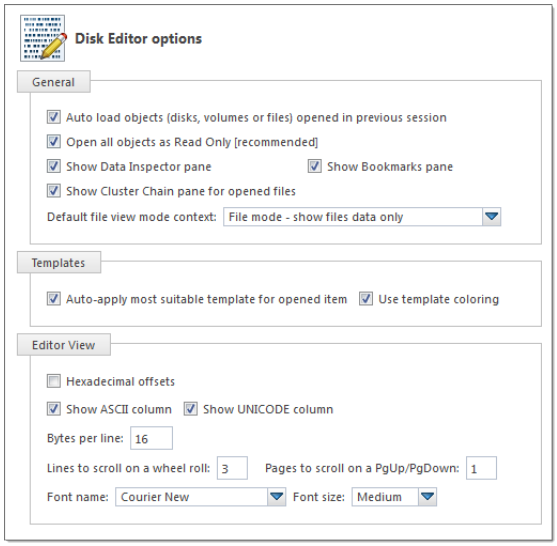
Default disk initialization

Specify devices type that will be initialized at each application start and will be displayed in **Recovery Explorer**.

Save log file to disk

Enable\Disable saving log entries to the file. Use Default log path to specify log file.

Disk Editor options



Auto load objects

Load (open) edited objects in Disk Editor at each application start if they present in system.

Open as Read Only

Open objects in Read Only mode by default.

Show Data Inspector pane

Show\Hide **Data Inspector** pane by default

Show Bookmark pane

Show\Hide **Bookmark** pane by default

Show Cluster Chain pane

Show\Hide **Cluster Chain** pane for edited files by default.

File view mode

Toggles default file view mode - files can be viewed as data

Auto apply template

If this option is ON, then most suitable data structure template for opened object will be applied and set visible.

Use template coloring

Toggle between template coloring or transparent template fields presentation.

Hexadecimal offset

Toggle between decimal and hexadecimal offset format

Show ASCII

Show\Hide ASCII decoding column

Show UNICODE

Show\Hide UNICODE decoding column

Bytes per line

Defines bytes per line representation. Minimum 8 bytes and maximum 255 bytes per line.

Lines per wheel scroll

Number of lines on each single mouse wheel scroll action.

Pages per scroll

Pages to scroll on each PageUp or PageDown keyboard button action.

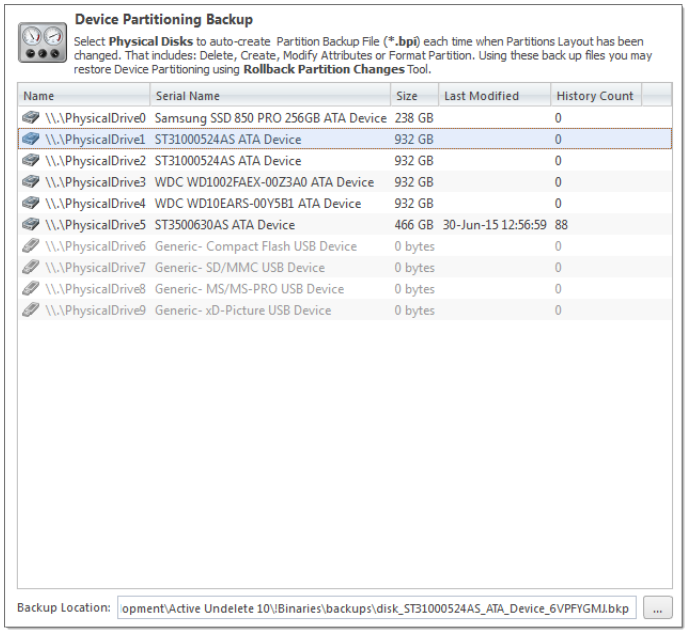
Font name

List of mono-space font faces available in system to use in Disk Editor view.

Font size

Toggle between relative font size.

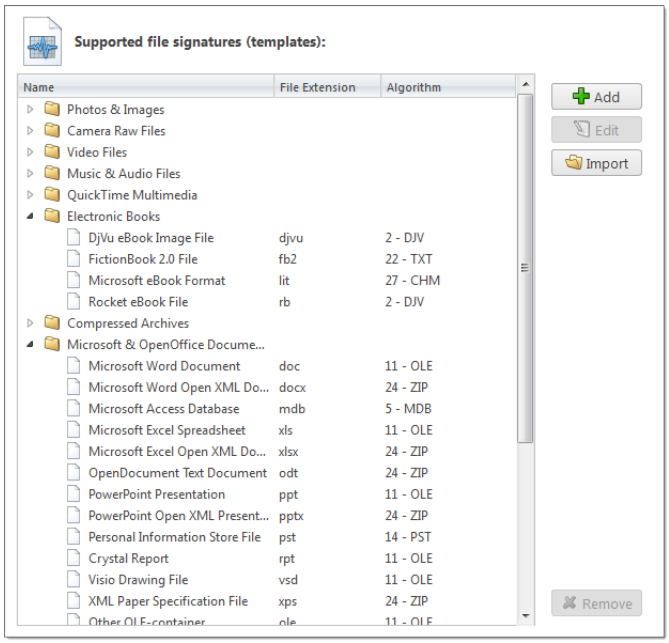
Device backups options


Device Partitioning Backup
Select Physical Disks to auto-create Partition Backup File (*.bpi) each time when Partitions Layout has been changed. That includes: Delete, Create, Modify Attributes or Format Partition. Using these back up files you may restore Device Partitioning using Rollback Partition Changes Tool.
Name
Serial Name
Size
Last Modified
History Count
\\.\PhysicalDrive0 Samsung SSD 850 PRO 256GB ATA Device 238 GB 0
\\.\PhysicalDrive1 ST31000524AS ATA Device 932 GB 0
\\.\PhysicalDrive2 ST31000524AS ATA Device 932 GB 0
\\.\PhysicalDrive3 WDC WD1002FAEX-00Z3A0 ATA Device 932 GB 0
\\.\PhysicalDrive4 WDC WD10EARS-00Y5B1 ATA Device 932 GB 0
\\.\PhysicalDrive5 ST3500630AS ATA Device 466 GB 30-Jun-15 12:56:59 88
\\.\PhysicalDrive6 Generic- Compact Flash USB Device 0 bytes 0
\\.\PhysicalDrive7 Generic- SD/MMC USB Device 0 bytes 0
\\.\PhysicalDrive8 Generic- MS/MS-PRO USB Device 0 bytes 0
\\.\PhysicalDrive9 Generic- xD-Picture USB Device 0 bytes 0
Backup Location:
opment\Active Undelete 10\Binaries\backups\disk_ST31000524AS_ATA_Device_6VPFYGMJ.bkp
...

Backup location

Define individually Physical Device (disk) backup file location. See *Rollback partition changes* on page 111 for details.

File signatures options


Supported file signatures (templates):
Name
File Extension
Algorithm
Photos & Images
Camera Raw Files
Video Files
Music & Audio Files
QuickTime Multimedia
Electronic Books
DjVu eBook Image File djvu 2 - DJV
FictionBook 2.0 File fb2 22 - TXT
Microsoft eBook Format lit 27 - CHM
Rocket eBook File rb 2 - DJV
Compressed Archives
Microsoft & OpenOffice Docume...
Microsoft Word Document doc 11 - OLE
Microsoft Word Open XML Do... docx 24 - ZIP
Microsoft Access Database mdb 5 - MDB
Microsoft Excel Spreadsheet xls 11 - OLE
Microsoft Excel Open XML Do... xlsx 24 - ZIP
OpenDocument Text Document odt 24 - ZIP
PowerPoint Presentation ppt 11 - OLE
PowerPoint Open XML Present... pptx 24 - ZIP
Personal Information Store File pst 14 - PST
Crystal Report rpt 11 - OLE
Visio Drawing File vsd 11 - OLE
XML Paper Specification File xps 24 - ZIP
Add
Edit
Import
Remove

File signatures list

Review available (supported) file signatures. User defined file signatures (if any) are shown in separate group.

Add file signature

Click **Add** button to add user define file signature. See *Custom (user defined) file signature templates* on page 43.

Edit file signature

Click **Edit** button when custom file signature is selected or double click custom file signature node to open edit dialog.

Import Custom file signatures

Click **Import** button to import custom file signatures define in third party configuration file.

Knowledge Base

Knowledge Base overview

Active@ UNDELETE is an advanced data recovery tool designed to recover data lost or deleted data, or even information from formatted hard disks.

To understand underlying mechanisms of data storage and logical organization, data recovery and analysis, the following topics will give essential concepts:

Understanding Hardware and Disk Organization

Basic information about Hard Disk Drives (HDD) and low-level disk organization.

Understanding File System (FAT)

The FAT file system is a simple file system originally designed for small disks and simple folder structures. The FAT file system is named for its method of organization, the File Allocation Table, which resides at the beginning of the volume. To protect the volume, two copies of the table are kept, in case one becomes damaged. In addition, the file allocation tables and the root folder must be stored in a fixed location so that the files needed to start the system can be correctly located.

Understanding File System (NTFS)

The Windows NT file system (NTFS) provides a combination of performance, reliability, and compatibility not found in the FAT file system. It is designed to quickly perform standard file operations such as read, write, and search — and even advanced operations such as file-system recovery — on very large hard disks.

Data Recovery Concept **on page 183**

Basic introduction and underlying mechanisms of data recover.

Understanding Recovery Process

Describes basic approaches and techniques of File and Folder recovery process.

Understanding Partition Recovery Process

Describes most common partition failures and techniques of their recovery.

Hardware and Disk Organization

Understanding of underlying mechanisms of data storage, organization and data recovery.

Here you can get some information about Hard Disk Drives (HDD) and low-level disk organization:

- *Hard Disk Drive Basics* on page 136
- *Master Boot Record (MBR)* on page 138
- *Partition Table* on page 140

Hard Disk Drive Basics

Understanding of underlying mechanisms of data storage, organization and data recovery.

A hard disk is a sealed unit containing a number of *platters* in a stack. Hard disks may be mounted in a horizontal or a vertical position. In this description, the hard drive is mounted horizontally. Electromagnetic read/write *heads* are positioned above and below each platter. As the platters spin, the drive heads move in toward the center surface and out toward the edge. In this way, the drive heads can reach the entire surface of each platter.

Each disk consists of platters, rings on each side of each platter called tracks, and sections within each track called sectors. A sector is the smallest physical storage unit on a disk, almost always 512 bytes in size.

Figure below illustrates a hard disk with two platters. The remainder of this section describes the terms used on the figure.

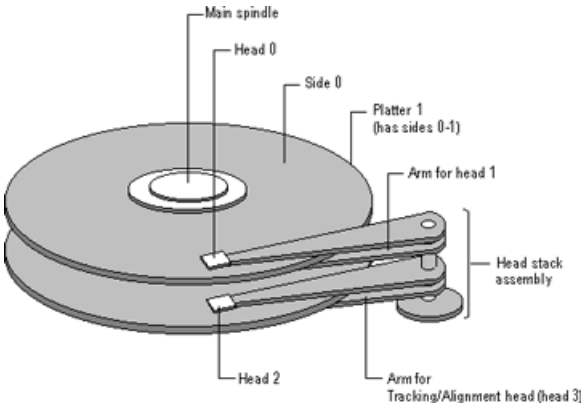


Figure 74: Two plated hard disk

The cylinder/head/sector notation scheme described in this section is slowly being eliminated. All new disks use some kind of translation factor to make their actual hardware layout appear as something else, mostly to work with MS-DOS and Windows 95.

Tracks and Cylinders

On hard disks, the data are stored on the disk in thin, concentric bands called *tracks*. There can be more than a thousand tracks on a 3½ inch hard disk. Tracks are a logical rather than physical structure, and are established when the disk is low-level formatted. Track numbers start at 0, and track 0 is the outermost track of the disk. The highest numbered track is next to the spindle. If the disk geometry is being translated, the highest numbered track would typically be 1023. Next figure shows track 0, a track in the middle of the disk, and track 1023.

A *cylinder* consists of the set of tracks that are at the same head position on the disk. In a figure below, cylinder 0 is the four tracks at the outermost edge of the sides of the platters. If the disk has 1024 cylinders (which would be numbered 0-1023), cylinder 1023 consists of all of the tracks at the innermost edge of each side.

Most disks used in personal computers today rotate at a constant angular velocity. The tracks near the outside of the disk are less densely populated with data than the tracks near the center of the disk. Thus, a fixed amount of data can be read in a constant period of time, even though the speed of the disk surface is faster on the tracks located further away from the center of the disk.

Modern disks reserve one side of one platter for track positioning information, which is written to the disk at the factory during disk assembly. It is not available to the operating system. The disk controller uses this information to fine tune the head locations when the heads move to another location on the disk. When a side contains the track position information, that side cannot be used for data. Thus, a disk assembly containing two platters has three sides that are available for data.

Sectors and Clusters

Each track is divided into sections called *sectors*. A sector is the smallest physical storage unit on the disk. The data size of a sector is always a power of two, and is almost always 512 bytes.

Each track has the same number of sectors, which means that the sectors are packed much closer together on tracks near the center of the disk. Next figure shows sectors on a track. You can see that sectors closer to the spindle are closer together than those on the outside edge of the disk. The disk controller uses the sector identification information stored in the area immediately before the data in the sector to determine where the sector itself begins.

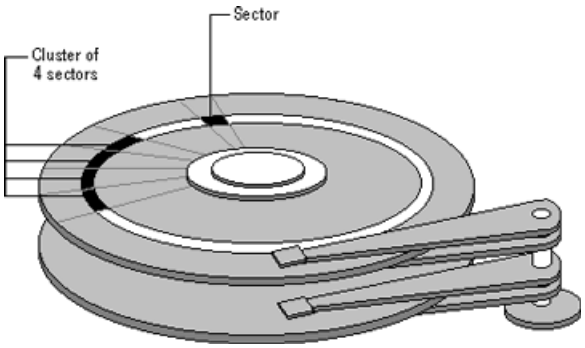


Figure 75: Clusters and sectors

As a file is written to the disk, the file system allocates the appropriate number of *clusters* to store the file's data. For example, if each cluster is 512 bytes and the file is 800 bytes, two clusters are allocated for the file. Later, if you update the file to, for example, twice its size (1600 bytes), another two clusters are allocated.

If contiguous clusters (clusters that are next to each other on the disk) are not available, the data are written elsewhere on the disk, and the file is considered to be *fragmented*. Fragmentation is a problem when the file system must search several different locations to find all the pieces of the file you want to read. The search causes a delay before the file is retrieved. A larger cluster size reduces the potential for fragmentation, but increases the likelihood that clusters will have unused space.

Using clusters larger than one sector reduces fragmentation, and reduces the amount of disk space needed to store the information about the used and unused areas on the disk.

The stack of platters rotate at a constant speed. The drive head, while positioned close to the center of the disk reads from a surface that is passing by more slowly than the surface at the outer edges of the disk. To compensate for this physical difference, tracks near the outside of the disk are less-densely populated with data than the tracks near the center of the disk. The result of the different data density is that the same amount of data can be read over the same period of time, from any drive head position.

The disk space is filled with data according to a standard plan. One side of one platter contains space reserved for hardware track-positioning information and is not available to the operating system. Thus, a disk assembly containing two platters has three sides available for data. Track-positioning data is written to the disk during assembly at the factory. The system *disk controller* reads this data to place the drive heads in the correct sector position.

Master Boot Record (MBR)

Understanding of underlying mechanisms of data storage, organization and data recovery.

The *Master Boot Record*, created when you create the first partition on the hard disk, is probably the most important data structure on the disk. It is the first sector on every disk. The location is always track (cylinder) 0, side (head) 0, and sector 1.

The Master Boot Record contains the *Partition Table* on page 140 for the disk and a small amount of executable code. On x86-based computers, the executable code examines the Partition Table, and identifies the system partition. The Master Boot Record then finds the system partition's starting location on the disk, and loads an copy of its Partition Boot Sector into memory. The Master Boot Record then transfers execution to executable code in the Partition Boot Sector.

Note:

Although there is a Master Boot Record on every hard disk, the executable code in the sector is used only if the disk is connected to an x86-based computer and the disk contains the system partition.

Figure below shows a hex dump of the sector containing the Master Boot Record. The figure shows the sector in two parts. The first part is the Master Boot Record, which occupies the first 446 bytes of the sector. The disk signature (FD 4E F2 14) is at the end of the Master Boot Record code. The second part is the *Partition Table* on page 140.

```
Physical Sector: Cyl 0, Side 0, Sector 1
```

```
       00000000: 00 33 C0 8E D0 BC 00 7C  -  8B F4 50 07 50 1F FB FC
 .3.....|..P.P..
       00000010: BF 00 06 B9 00 01 F2 A5  -  EA 1D 06 00 00 BE BE 07
 ................
       00000020: B3 04 80 3C 80 74 0E 80  -  3C 00 75 1C 83 C6 10 FE
 ...<.t..<.u.....
       00000030: CB 75 EF CD 18 8B 14 8B  -  4C 02 8B EE 83 C6 10 FE
 .u......L.......
       00000040: CB 74 1A 80 3C 00 74 F4  -  BE 8B 06 AC 3C 00 74 0B
 .t..<.t.....<.t.
       00000050: 56 BB 07 00 B4 0E CD 10  -  5E EB F0 EB FE BF 05 00
V.......^.......
       00000060: BB 00 7C B8 01 02 57 CD  -  13 5F 73 0C 33 C0 CD 13
 ..|...W.._s.3...
       00000070: 4F 75 ED BE A3 06 EB D3  -  BE C2 06 BF FE 7D 81 3D
Ou...........}.=
       00000080: 55 AA 75 C7 8B F5 EA 00  -  7C 00 00 49 6E 76 61 6C
U.u.....|..Inval
       00000090: 69 64 20 70 61 72 74 69  -  74 69 6F 6E 20 74 61 62   id
partition tab
       000000A0: 6C 65 00 45 72 72 6F 72  -  20 6C 6F 61 64 69 6E 67
le.Error loading
       000000B0: 20 6F 70 65 72 61 74 69  -  6E 67 20 73 79 73 74 65
operating syste
       000000C0: 6D 00 4D 69 73 73 69 6E  -  67 20 6F 70 65 72 61 74
m.Missing operat
       000000D0: 69 6E 67 20 73 79 73 74  -  65 6D 00 00 80 45 14 15   ing
system...E..
       000000E0: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       000000F0: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000100: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000110: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000120: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000130: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000140: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000150: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000160: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000170: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000180: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       00000190: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       000001A0: 00 00 00 00 00 00 00 00  -  00 00 00 00 00 00 00 00
 ................
       000001B0: 00 00 00 00 00 00 00 00  -  FD 4E F2 14 00 00 80 01
 .........N......
       000001C0: 01 00 06 0F 7F 96 3F 00  -  00 00 51 42 06 00 00 00
 ....□.?...QB....
       000001D0: 41 97 07 0F FF 2C 90 42  -  06 00 A0 3E 06 00 00 00
A....,.B...>....
       000001E0: C1 2D 05 0F FF 92 30 81  -  0C 00 A0 91 01 00 00 00
 .-....0.........
```

```
       000001F0: C1 93 01 0F FF A6 D0 12  -  0E 00 C0 4E 00 00 55 AA
...........N..U.
```

Important: Viruses Can Infect the Master Boot Record

Many destructive viruses damage the Master Boot Record and make it impossible to start the computer from the hard disk. Because the code in the Master Boot Record executes before any operating system is started, no operating system can detect or recover from corruption of the Master Boot Record. You can use, for example, the DiskProbe program on *Windows NT Workstation Resource Kit* CD to display the Master Boot Record, and compare it to the Master Boot Record shown above. There are also utilities on the Microsoft Windows Resource Kits that enable you to save and restore the Master Boot Record.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

Partition Table

Understanding of underlying mechanisms of data storage, organization and data recovery.

The information about primary partitions and an extended partition is contained in the Partition Table, a 64-byte data structure located in the same sector as the *Master Boot Record (MBR)* on page 138 (cylinder 0, head 0, sector 1). The Partition Table conforms to a standard layout that is independent of the operating system. Each Partition Table entry is 16 bytes long, making a maximum of four entries available. Each entry starts at a predetermined offset from the beginning of the sector, as follows:

- Partition 1 0x01BE (446)
- Partition 2 0x01CE (462)
- Partition 3 0x01DE (478)
- Partition 4 0x01EE (494)

The last two bytes in the sector are a signature word for the sector and are always 0x55AA.

The next figure is a printout of the Partition Table for the disk shown in a *Master Boot Record (MBR)* on page 138 earlier in this chapter. When there are fewer than four partitions, the remaining fields are all zeros.

```
000001B0:                                                 80 01                  ..
000001C0: 01 00 06 0F 7F 96 3F 00 - 00 00 51 42 06 00 00 00    ....□.?...QB.....
000001D0: 41 97 07 0F FF 2C 90 42 - 06 00 A0 3E 06 00 00 00    A....,.B...>....
000001E0: C1 2D 05 0F FF 92 30 81 - 0C 00 A0 91 01 00 00 00    .-....0.........
000001F0: C1 93 01 0F FF A6 D0 12 - 0E 00 C0 4E 00 00 55 AA    ...........N..U.
```

The following table describes each entry in the Partition Table. The sample values correspond to the information for partition 1.

Table 1: Partition Table Fields

Byte Offset	Field Length	Sample Value	Meaning
00	BYTE	0x80	Boot Indicator. Indicates whether the partition is the system partition. Legal values are: 00 = Do not use for booting. 80 = System partition.
01	BYTE	0x01	Starting Head.
02	6 bits	0x01	Starting Sector. Only bits 0-5 are used. Bits 6-7 are the upper two bits for the Starting Cylinder field.
03	10 bits	0x00	Starting Cylinder. This field contains the lower 8 bits of the cylinder value. Starting cylinder is thus a 10-bit number, with a maximum value of 1023.

Byte Offset	Field Length	Sample Value	Meaning
04	BYTE	0x06	System ID. This byte defines the volume type. In Windows NT, it also indicates that a partition is part of a volume that requires the use of the HKEY_LOCAL_MACHINE \SYSTEM\DISK Registry subkey.
05	BYTE	0x0F	Ending Head.
06	6 bits	0x3F	Ending Sector. Only bits 0-5 are used. Bits 6-7 are the upper two bits for the Ending Cylinder field.
07	10 bits	0x196	Ending Cylinder. This field contains the lower 8 bits of the cylinder value. Ending cylinder is thus a 10-bit number, with a maximum value of 1023.
08	DWORD	3F 00 00 00	Relative Sector.
12	DWORD	01 42 06 00	Total Sectors.

The remainder of this section describes the uses of these fields. Definitions of the fields in the Partition Table is the same for primary partitions, extended partitions, and logical drives in extended partitions.

Boot Indicator Field

The Boot Indicator field indicates whether the volume is the system partition. On x-86-based computers, only one primary partition on the disk should have this field set. This field is used only on x86-based computers. On RISC-based computers, the NVRAM contains the information for finding the files to load.

On x86-based computers, it is possible to have different operating systems and different file systems on different volumes. For example, a computer could have MS-DOS on the first primary partition and Windows 95, UNIX, OS/2, or Windows NT on the second. You control which primary partition (active partition in FDISK) to use to start the computer by setting the Boot Indicator field for that partition in the Partition Table.

System ID Field

For primary partitions and logical drives, the System ID field describes the file system used to format the volume. Windows NT uses this field to determine what file system device drivers to load during startup. It also identifies the extended partition, if there is one defined.

Table 2: System ID field description

Value	Meaning
0x01	12-bit FAT primary partition or logical drive. The number of sectors in the volume is fewer than 32680.
0x04	16-bit FAT primary partition or logical drive. The number of sectors is between 32680 and 65535.
0x05	Extended partition. See section titled "Logical Drives and Extended Partitions," presented later in this chapter, for more information.
0x06	BIGDOS FAT primary partition or logical drive.
0x07	NTFS primary partition or logical drive.

Figure presented earlier in this section, has examples of a BIGDOS FAT partition, an NTFS partition, an extended partition, and a 12-bit FAT partition.

If you install Windows NT on a computer that has Windows 95 preinstalled, the FAT partitions might be shown as unknown. If you want to be able to use these partitions when running Windows NT, your only option is to delete the partitions.

OEM versions of Windows 95 support the following four partition types for FAT file systems that Windows NT cannot recognize.

Value	Meaning
0x0B	Primary Fat32 partition, using interrupt 13 (INT 13) extensions.
0x0C	Extended Fat32 partition, using INT 13 extensions.
0x0E	Extended Fat16 partition, using INT 13 extensions.
0x0F	Primary Fat16 partition, using INT 13 extensions.

When you create a volume set or a stripe set, Disk Administrator sets the high bit of the System ID field for each primary partition or logical drive that is a member of the volume. For example, a FAT primary partition or logical drive that is a member of a volume set or a stripe set has a System ID value of 0x86. An NTFS primary partition or logical drive has a System ID value of 0x87. This bit indicates that Windows NT needs to use the HKEY_LOCAL_MACHINE\SYSTEM\DISK Registry subkey to determine how the members of the volume set or stripe set relate to each other. Volumes that have the high bit set can only be accessed by Windows NT.

When a primary partition or logical drive that is a member of a volume set or a stripe set has failed due to write errors or cannot be accessed, the second most significant bit is set. The System ID byte is set to C6 in the case of a FAT volume, or C7 in the case of an NTFS volume.

Note:

If you start up MS-DOS, it can only access primary partitions or logical drives that have a value of 0x01, 0x04, 0x05, or 0x06 for the System ID. However, you should be able to delete volumes that have the other values. If you use a MS-DOS-based low-level disk editor, you can read and write any sector, including ones that are in NTFS volumes.

On Windows NT Server, mirror sets and stripe sets with parity also require the use of the Registry subkey HKEY_LOCAL_MACHINE\SYSTEM\DISK to determine how to access the disks.

Starting and Ending Head, Sector, and Cylinder Fields

On x86-based computers, the Starting and Ending Head, Cylinder, and Sector fields on the start-up disk are very important for starting up the computer. The code in the Master Boot Record uses these fields to find and load the Partition Boot Sector.

The Ending Cylinder field in the Partition Table is ten bits long, which limits the maximum number of cylinders that can be described in the Partition Table to 1024. The Starting and Ending Head fields are one byte long, which limits this field to the range 0 – 255. The Starting and Ending Sector field is 6 bits long, limiting its range to 0 – 63. However, sectors start counting at 1 (versus 0 for the other fields), so the maximum number of sectors per track is 63.

Since current hard disks are low-level formatted with the industry standard 512-byte sector size, the maximum capacity disk that can be described by the Partition Table can be calculated as follows:

```
  MaxCapacity = (sector size) x (sectors per track) x (cylinders) x (heads)
```

Substituting the maximum possible values yields:

```
512 x 63 x 1024 x 256 = 8,455,716,864 bytes or 7.8 GB
```

The maximum formatted capacity is slightly less than 8 GB.

However, the maximum cluster size that you can use for FAT volumes when running Windows NT is 64K, when using a 512 byte sector size. Therefore, the maximum size for a FAT volume is 4 GB.

If you have a dual-boot configuration with Windows 95 or MS-DOS, FAT volumes that might be accessed when using either of those operating systems are limited to 2 GB. In addition, Macintosh computers that are viewing

volumes on a computer running Windows NT cannot see more than 2 GB. If you try to use a FAT volume larger than 2 GB when running MS-DOS or Windows 95, or access it from a Macintosh computer, you might get a message that there are 0 bytes available. The same limit applies to OS/2 system and boot partitions.

The maximum size of a FAT volume on a specific computer depends on the disk geometry, and the maximum values that can fit in the fields described in this section. The next table shows the typical size of a FAT volume when translation is enabled, and when it is disabled. The number of cylinders in both situations is 1024.

Translation mode	Numb of heads	Sector per track	Maximum size for system or boot partition
Disabled	64	32	1 GB
Enabled	255	63	4 GB

Note:

RISC-based computers do not have a limit on the size of the system or boot partitions.

If a primary partition or logical drive extends beyond cylinder 1023, all of these fields will contain the maximum values.

Relative Sectors and Number of Sectors Fields

For primary partitions, the Relative Sectors field represents the offset from the beginning of the disk to the beginning of the partition, counting by sectors. The Number of Sectors field represents the total number of sectors in the partition. For a description of these fields in extended partitions, see the section *Logical Drives and Extended Partitions*.

Windows NT uses these fields to access all partitions. When you format a partition when running Windows NT, it puts data into the Starting and Ending Cylinder, Head, and Sector fields only for backward compatibility with MS-DOS and Windows 95, and to maintain compatibility with the BIOS interrupt (INT) 13 for start-up purposes.

Logical Drives and Extended Partitions

When more than four logical disks are required on a single physical disk, the first partition should be a primary partition. The second partition can be created as an extended partition, which can contain all the remaining unpartitioned space on the disk.

Note:

A primary partition is one that can be used as the system partition. If the disk does not contain a system partition, you can configure the entire disk as a single, extended partition.

Some computers create an EISA configuration partition as the first partition on the hard disk.

Windows NT detects an extended partition because the System ID byte in the Partition Table entry is set to 5. There can be only one extended partition on a hard disk.

Within the extended partition, you can create any number of logical drives. As a practical matter, the number of available drive letters is the limiting factor in the number of logical drives that you can define.

When you have an extended partition on the hard disk, the entry for that partition in the Partition Table (at the end of the Master Boot Record) points to the first disk sector in the extended partition. The first sector of each logical drive in an extended partition also has a Partition Table, which is the last 66 bytes of the sector. (The last two bytes of the sector are the end-of-sector marker.)

These are the entries in an extended Partition Table:

- The first entry is for the current logical drive.
- The second entry contains information about the next logical drive in the extended partition.
- Entries three and four are all zeroes.

This format repeats for every logical drive. The last logical drive has only its own partition entry listed. The entries for partitions 2-4 are all zeroes.

The Partition Table entry is the only information on the first side of the first cylinder of each logical drive in the extended partition. The entry for partition 1 in each Partition Table contains the starting address for data on the current logical drive. And the entry for partition 2 is the address of the sector that contains the Partition Table for the next logical drive.

The use of the Relative Sector and Total Sectors fields for logical drives in an extended partition is different than for primary partitions. For the partition 1 entry of each logical drive, the Relative Sectors field is the sector from the beginning of the logical drive that contains the Partition Boot Sector. The Total Sectors field is the number of sectors from the Partition Boot Sector to the end of the logical drive.

For the partition 2 entry, the Relative Sectors field is the offset from the beginning of the extended partition to the sector containing the Partition Table for the logical drive defined in the Partition 2 entry. The Total Sectors field is the total size of the logical drive defined in the Partition 2 entry.

Note:

If a logical drive is part of a volume set, the Partition Boot Sector is at the beginning of the first member of the volume set. Other members of the volume set have data where the Partition Boot Sector would normally be located.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

Disk arrays (RAID's)

Redundant array of independent disks (RAID)

Redundant array of independent disks (RAID) is a storage technology that combines multiple disk drive components into a logical unit. Data is distributed across the drives in one of several ways called "RAID levels", depending on what level of redundancy and performance (via parallel communication) is required.

RAID types

RAID-0

This technique has striping but no redundancy of data. It offers the best performance but no fault-tolerance.

RAID-1

This type is also known as disk mirroring and consists of at least two drives that duplicate the storage of data. There is no striping. Read performance is improved since either disk can be read at the same time. Write performance is the same as for single disk storage. RAID-1 provides the best performance and the best fault-tolerance in a multi-user system.

RAID-2

This type uses striping across disks with some disks storing error checking and correcting (ECC) information. It has no advantage over RAID-3.

RAID-3

This type uses striping and dedicates one drive to storing parity information. The embedded error checking (ECC) information is used to detect errors. Data recovery is accomplished by calculating the exclusive OR (XOR) of the information recorded on the other drives. Since an I/O operation addresses all drives at the same time, RAID-3 cannot overlap I/O. For this reason, RAID-3 is best for single-user systems with long record applications.

RAID-4

This type uses large stripes, which means you can read records from any single drive. This allows you to take advantage of overlapped I/O for read operations. Since all write operations have to update the parity drive, no I/O overlapping is possible. RAID-4 offers no advantage over RAID-5.

RAID-5

This type includes a rotating parity array, thus addressing the write limitation in RAID-4. Thus, all read and write operations can be overlapped. RAID-5 stores parity information but not redundant data (but parity information can be used to reconstruct data). RAID-5 requires at least three and usually five disks for the array. It's best for multi-user systems in which performance is not critical or which do few write operations.

Parity tables

Left Synchronous			
0	5	6	P
1	4	P	11
2	P	7	10
P	3	8	9

Left Asynchronous			
0	3	6	P
1	4	P	9
2	P	7	10
P	5	8	11

Right Synchronous			
P	5	6	11
0	P	7	10
1	4	P	9
2	3	8	P

Right Asynchronous			
P	3	6	9
0	P	7	10
1	4	P	11
2	5	8	P

Logical Disk Manager (LDM) overview

Understanding of underlying mechanisms of data storage, organization and data recovery.

Dynamic disks provide features that basic disks do not, such as the ability to create volumes that span multiple disks (spanned and striped volumes), and the ability to create fault tolerant volumes (mirrored and RAID-5 volumes). All volumes on dynamic disks are known as dynamic volumes.

There are five types of dynamic volumes:

Simple

A dynamic volume made up of disk space from a single dynamic disk. A simple volume can consist of a single region on a disk or multiple regions of the same disk that are linked together. If the simple volume is not a system volume or boot volume, you can extend it within the same disk or onto additional disks. If you extend a simple volume across multiple disks, it becomes a spanned volume. You can create simple volumes only on dynamic disks. Simple volumes are not fault tolerant, but you can mirror them to create mirrored volumes on computers running the Windows 2000 Server or Windows Server 2003 families of operating systems.

Spanned

A dynamic volume consisting of disk space on more than one physical disk. You can increase the size of a spanned volume by extending it onto additional dynamic disks. You can create spanned volumes only on dynamic disks. Spanned volumes are not fault tolerant and cannot be mirrored.

Striped

A dynamic volume that stores data in stripes on two or more physical disks. Data in a striped volume is allocated alternately and evenly (in stripes) across the disks. Striped volumes offer the best performance of all the volumes that are available in Windows, but they do not provide fault tolerance. If a disk in a striped volume fails, the data in the entire volume is lost. You can create striped volumes only on dynamic disks. Striped volumes cannot be mirrored or extended.

Mirrored

A fault-tolerant volume that duplicates data on two physical disks. A mirrored volume provides data redundancy by using two identical volumes, which are called mirrors, to duplicate the information contained on the volume. A mirror is always located on a different disk. If one of the physical disks fails, the data on the failed disk becomes unavailable, but the system continues to operate in the mirror on the remaining disk. You can create mirrored volumes only on dynamic disks on computers running the Windows 2000 Server or Windows Server 2003 families of operating systems. You cannot extend mirrored volumes.

RAID-5

A fault-tolerant volume with data and parity striped intermittently across three or more physical disks. Parity is a calculated value that is used to reconstruct data after a failure. If a portion of a physical disk fails, Windows recreates the data that was on the failed portion from the remaining data and parity. You can create RAID-5 volumes only on dynamic disks on computers running the Windows 2000 Server or Windows Server 2003 families of operating systems. You cannot mirror or extend RAID-5 volumes. In Windows NT 4.0, a RAID-5 volume was known as a striped set with parity.

Mirrored and RAID-5 volumes are fault tolerant and are available only on computers running Windows 2000 Server, Windows 2000 Advanced Server, Windows 2000 Datacenter Server, or the Windows Server 2003 family of operating systems. You can, however, use a computer running Windows XP Professional to remotely create mirrored and RAID-5 volumes on these operating systems.

Regardless of whether the dynamic disk uses the master boot record (MBR) or GUID partition table (GPT) partition style, you can create up to 2,000 dynamic volumes, although the recommended number of dynamic volumes is 32 or less.

For information about how to manage dynamic volumes, see *Manage dynamic volumes*.

File Systems

Windows NT File System (NTFS)

Understanding of underlying mechanisms of data storage, organization and data recovery.

The Windows NT file system (NTFS) provides a combination of performance, reliability, and compatibility not found in the FAT file system. It is designed to quickly perform standard file operations such as read, write, and search — and even advanced operations such as file-system recovery — on very large hard disks.

Formatting a volume with the NTFS file system results in the creation of several system files and the Master File Table (MFT), which contains information about all the files and folders on the NTFS volume.

The first information on an NTFS volume is the Partition Boot Sector, which starts at sector 0 and can be up to 16 sectors long. The first file on an NTFS volume is the Master File Table (MFT).

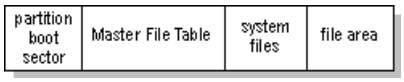


Figure 76: Layout of NTFS volume after formatting

See the next sections for more information about NTFS:

- *NTFS Partition Boot Sector* on page 147
- *NTFS Master File Table (MFT)* on page 150
- *NTFS File Types* on page 151
- *Data Integrity and Recoverability with NTFS* on page 154

The NTFS file system includes security features required for file servers and high-end personal computers in a corporate environment. The NTFS file system also supports data access control and ownership privileges that are important for the integrity of critical data. While folders shared on a Windows NT computer are assigned particular permissions, NTFS files and folders can have permissions assigned whether they are shared or not. NTFS is the only file system on Windows NT that allows you to assign permissions to individual files.

The NTFS file system has a simple, yet very powerful design. Basically, everything on the volume is a file and everything in a file is an attribute, from the data attribute, to the security attribute, to the file name attribute. Every sector on an NTFS volume that is allocated belongs to some file. Even the file system metadata (information that describes the file system itself) is part of a file.

What's New in NTFS5 (Windows 2000)

Encryption

The Encrypting File System (EFS) provides the core file encryption technology used to store encrypted files on NTFS volumes. EFS keeps files safe from intruders who might gain unauthorized physical access to sensitive, stored data (for example, by stealing a portable computer or external disk drive).

Disk quotas

Windows 2000 supports disk quotas for NTFS volumes. You can use disk quotas to monitor and limit disk-space use.

Reparse points

Reparse points are new file system objects in NTFS that can be applied to NTFS files or folders. A file or folder that contains a reparse point acquires additional behaviour not present in the underlying file system. Reparse points are used by many of the new storage features in Windows 2000, including volume mount points.

Volume mount points

Volume mount points are new to NTFS. Based on reparse points, volume mount points allow administrators to graft access to the root of one local volume onto the folder structure of another local volume.

Sparse files

Sparse files allow programs to create very large files but consume disk space only as needed.

Distributed link tracking

NTFS provides a link-tracking service that maintains the integrity of shortcuts to files as well as OLE links within compound documents.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

NTFS Partition Boot Sector

Understanding of underlying mechanisms of data storage, organization and data recovery.

Next table describes the boot sector of a volume formatted with NTFS. When you format an NTFS volume, the format program allocates the first 16 sectors for the boot sector and the bootstrap code.

Byte Offset	Field Length	Field Name
0x00	3 bytes	Jump Instruction
0x03	LONGLONG	OEM ID
0x0B	25 bytes	BPB
0x24	48 bytes	Extended BPB
0x54	426 bytes	Bootstrap Code
0x01FE	WORD	End of Sector Marker

On NTFS volumes, the data fields that follow the BPB form an extended BPB. The data in these fields enables Ntldr (NT loader program) to find the master file table (MFT) during startup. On NTFS volumes, the MFT is not located in a predefined sector, as on FAT16 and FAT32 volumes. For this reason, the MFT can be moved if there is a bad sector in its normal location. However, if the data is corrupted, the MFT cannot be located, and Windows NT/2000 assumes that the volume has not been formatted.

The following example illustrates the boot sector of an NTFS volume formatted while running Windows 2000. The printout is formatted in three sections:

- Bytes 0x00– 0x0A are the jump instruction and the OEM ID (shown in bold print).
- Bytes 0x0B–0x53 are the BPB and the extended BPB.
- The remaining code is the bootstrap code and the end of sector marker (shown in bold print).

```
  Physical Sector: Cyl 0, Side 1, Sector 1

  00000000: EB 52 90 4E 54 46 53 20 - 20 20 20 00 02 08 00
 00 .R.NTFS ........
  00000010: 00 00 00 00 00 F8 00 00 - 3F 00 FF 00 3F 00 00 00 ........?...?...
  00000020: 00 00 00 00 80 00 80 00 - 4A F5 7F 00 00 00 00
 00 ........J.......
  00000030: 04 00 00 00 00 00 00 00 - 54 FF 07 00 00 00 00
 00 ........T.......
  00000040: F6 00 00 00 01 00 00 00 - 14 A5 1B 74 C9 1B 74
 1C ...........t..t.
  00000050: 00 00 00 00 FA 33 C0 8E - D0 BC 00 7C FB B8 C0 07.....3.....|....
  00000060: 8E D8 E8 16 00 B8 00 0D - 8E C0 33 DB C6 06 0E
 00 ..........3.....
  00000070: 10 E8 53 00 68 00 0D 68 - 6A 02 CB 8A 16 24 00 B4 ..S.h..hj....
$..
  00000080: 08 CD 13 73 05 B9 FF FF - 8A F1 66 0F B6 C6 40
 66 ...s......f...@f
  00000090: 0F B6 D1 80 E2 3F F7 E2 - 86 CD C0 ED 06 41 66
 0F .....?.......Af.
  000000A0: B7 C9 66 F7 E1 66 A3 20 - 00 C3 B4 41 BB AA 55 8A ..f..f. ...A..U.
  000000B0: 16 24 00 CD 13 72 0F 81 - FB 55 AA 75 09 F6 C1 01 .$...r...U.u....
  000000C0: 74 04 FE 06 14 00 C3 66 - 60 1E 06 66 A1 10 00 66 t......f`..f...f
  000000D0: 03 06 1C 00 66 3B 06 20 - 00 0F 82 3A 00 1E 66 6A ....f;. ...:..fj
  000000E0: 00 66 50 06 53 66 68 10 - 00 01 00 80 3E 14 00 00 .fP.Sfh.....>...
  000000F0: 0F 85 0C 00 E8 B3 FF 80 - 3E 14 00 00 0F 84 61 00 ........>.....a.
  00000100: B4 42 8A 16 24 00 16 1F - 8B F4 CD 13 66 58 5B 07 .B..$......fX[..
  00000110: 66 58 66 58 1F EB 2D 66 - 33 D2 66 0F B7 0E 18 00 fXfX.-f3.f......
  00000120: 66 F7 F1 FE C2 8A CA 66 - 8B D0 66 C1 EA 10 F7 36 f......f..f....6
  00000130: 1A 00 86 D6 8A 16 24 00 - 8A E8 C0 E4 06 0A CC B8 ......$.........
  00000140: 01 02 CD 13 0F 82 19 00 - 8C C0 05 20 00 8E C0 66 ........... ...f
```

```
 00000150: FF 06 10 00 FF 0E 0E 00 - 0F 85 6F FF 07 1F 66 61 ..........o...fa
 00000160: C3 A0 F8 01 E8 09 00 A0 - FB 01 E8 03 00 FB EB FE ................
 00000170: B4 01 8B F0 AC 3C 00 74 - 09 B4 0E BB 07 00 CD 10 .....<.t........
 00000180: EB F2 C3 0D 0A 41 20 64 - 69 73 6B 20 72 65 61 64 .....A disk read
 00000190: 20 65 72 72 6F 72 20 6F - 63 63 75 72 72 65 64 00  error occurred.
 000001A0: 0D 0A 4E 54 4C 44 52 20 - 69 73 20 6D 69 73 73 69 ..NTLDR is missi
 000001B0: 6E 67 00 0D 0A 4E 54 4C - 44 52 20 69 73 20 63 6F ng...NTLDR is co
 000001C0: 6D 70 72 65 73 73 65 64 - 00 0D 0A 50 72 65 73 73 mpressed...Press
 000001D0: 20 43 74 72 6C 2B 41 6C - 74 2B 44 65 6C 20 74 6F  Ctrl+Alt+Del
to
 000001E0: 20 72 65 73 74 61 72 74 - 0D 0A 00 00 00 00 00 00  restart........
 000001F0: 00 00 00 00 00 00 00 00 - 83 A0 B3 C9 00 00 55 AA ..............U.
```

The following table describes the fields in the BPB and the extended BPB on NTFS volumes. The fields starting at 0x0B, 0x0D, 0x15, 0x18, 0x1A, and 0x1C match those on FAT16 and FAT32 volumes. The sample values correspond to the data in this example.

Table 3: BIOS Parameter Block and Extended BIOS Parameter Block Fields

Byte Offset	Field Length	Sample Value	Field Name
0x0B	WORD	0x0002	Bytes Per Sector
0x0D	BYTE	0x08	Sectors Per Cluster
0x0E	WORD	0x0000	Reserved Sectors
0x10	3 BYTES	0x000000	*always 0*
0x13	WORD	0x0000	*not used by NTFS*
0x15	BYTE	0xF8	Media Descriptor
0x16	WORD	0x0000	*always 0*
0x18	WORD	0x3F00	Sectors Per Track
0x1A	WORD	0xFF00	Number Of Heads
0x1C	DWORD	0x3F000000	Hidden Sectors
0x20	DWORD	0x00000000	*not used by NTFS*
0x24	DWORD	0x80008000	*not used by NTFS*
0x28	LONGLONG	0x4A5F7600	Total Sectors
0x30	LONGLONG	0x4000000000000000	Logical Cluster Number for the file $MFT
0x38	LONGLONG	0x54FF070000000000	Logical Cluster Number for the file $MFTMirr
0x40	DWORD	0xF6000000	Clusters Per File Record Segment
0x44	DWORD	0x01000000	Clusters Per Index Block
0x48	LONGLONG	0x14A5B74C9BB741	Volume Serial Number
0x50	DWORD	0x00000000	Checksum

Protecting the Boot Sector

Because a normally functioning system relies on the boot sector to access a volume, it is highly recommended that you run disk scanning tools such as Chkdsk regularly, as well as back up all of your data files to protect against data loss if you lose access to a volume.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

NTFS Master File Table (MFT)

Understanding of underlying mechanisms of data storage, organization and data recovery.

Each file on an NTFS volume is represented by a record in a special file called the master file table (MFT). NTFS reserves the first 16 records of the table for special information. The first record of this table describes the master file table itself, followed by a MFT *mirror record*. If the first MFT record is corrupted, NTFS reads the second record to find the MFT mirror file, whose first record is identical to the first record of the MFT. The locations of the data segments for both the MFT and MFT mirror file are recorded in the boot sector. A duplicate of the boot sector is located at the logical center of the disk.

The third record of the MFT is the log file, used for file recovery. The seventeenth and following records of the master file table are for each file and directory (also viewed as a file by NTFS) on the volume.

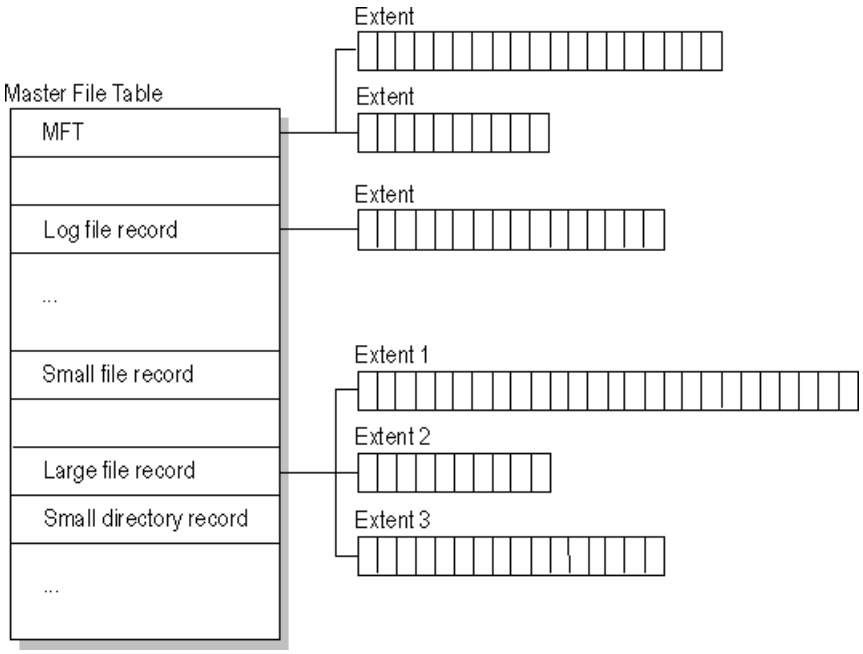


Figure 77: Simplified illustration of the MFT structure

The master file table allocates a certain amount of space for each file record. The attributes of a file are written to the allocated space in the MFT. Small files and directories (typically 1500 bytes or smaller), such as the file illustrated in next figure, can entirely be contained within the master file table record.

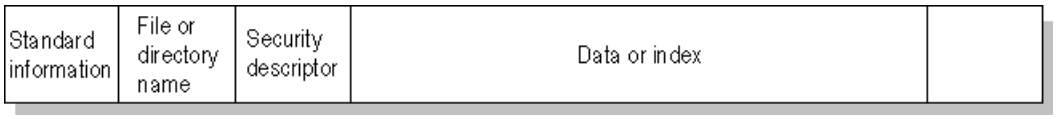


Figure 78: MFT Record for a Small File or Directory

This design makes file access very fast. Consider, for example, the FAT file system, which uses a file allocation table to list the names and addresses of each file. FAT directory entries contain an index into the file allocation table. When you want to view a file, FAT first reads the file allocation table and assures that it exists. Then FAT retrieves the file by searching the chain of allocation units assigned to the file. With NTFS, as soon as you look up the file, it's there for you to use.

Directory records are housed within the master file table just like file records. Instead of data, directories contain index information. Small directory records reside entirely within the MFT structure. Large directories are organized

into B-trees, having records with pointers to external clusters containing directory entries that could not be contained within the MFT structure.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

NTFS File Types

Understanding of underlying mechanisms of data storage, organization and data recovery.

NTFS File Attributes

The NTFS file system views each file (or folder) as a set of file attributes. Elements such as the file's name, its security information, and even its data, are all file attributes. Each attribute is identified by an attribute type code and, optionally, an attribute name.

When a file's attributes can fit within the MFT file record, they are called resident attributes. For example, information such as filename and time stamp are always included in the MFT file record. When all of the information for a file is too large to fit in the MFT file record, some of its attributes are non-resident. The non-resident attributes are allocated one or more clusters of disk space elsewhere in the volume. NTFS creates the Attribute List attribute to describe the location of all of the attribute records.

Next table lists all of the file attributes currently defined by the NTFS file system. This list is extensible, meaning that other file attributes can be defined in the future.

Attribute Type	Description
Standard Information	Includes information such as timestamp and link count.
Attribute List	Lists the location of all attribute records that do not fit in the MFT record.
File Name	A repeatable attribute for both long and short file names. The long name of the file can be up to 255 Unicode characters. The short name is the 8.3, case-insensitive name for the file. Additional names, or hard links, required by POSIX can be included as additional file name attributes.
Security Descriptor	Describes who owns the file and who can access it.
Data	Contains file data. NTFS allows multiple data attributes per file. Each file typically has one unnamed data attribute. A file can also have one or more named data attributes, each using a particular syntax.
Object ID	A volume-unique file identifier. Used by the distributed link tracking service. Not all files have object identifiers.
Logged Tool Stream	Similar to a data stream, but operations are logged to the NTFS log file just like NTFS metadata changes. This is used by EFS.
Reparse Point	Used for volume mount points. They are also used by Installable File System (IFS) filter drivers to mark certain files as special to that driver.
Index Root	Used to implement folders and other indexes.
Index Allocation	Used to implement folders and other indexes.
Bitmap	Used to implement folders and other indexes.
Volume Information	Used only in the $Volume system file. Contains the volume version.
Volume Name	Used only in the $Volume system file. Contains the volume label.

NTFS System Files

NTFS includes several system files, all of which are hidden from view on the NTFS volume. A *system file* is one used by the file system to store its metadata and to implement the file system. System files are placed on the volume by the Format utility.

Table 4: Metadata Stored in the Master File Table

System File	File Name	MFT Record	Purpose of the File
Master file table	$Mft	0	Contains one base file record for each file and folder on an NTFS volume. If the allocation information for a file or folder is too large to fit within a single record, other file records are allocated as well.
Master file table 2	$MftMir	1	A duplicate image of the first four records of the MFT. This file guarantees access to the MFT in case of a single-sector failure.
Log file	$LogFile	2	Contains a list of transaction steps used for NTFS recoverability. Log file size depends on the volume size and can be as large as 4 MB. It is used by Windows NT/2000 to restore consistency to NTFS after a system failure.
Volume	$Volume	3	Contains information about the volume, such as the volume label and the volume version.
Attribute definitions	$AttrDef	4	A table of attribute names, numbers, and descriptions.
Root file name index	$	5	The root folder.
Cluster bitmap	$Bitmap	6	A representation of the volume showing which clusters are in use.
Boot sector	$Boot	7	Includes the BPB used to mount the volume and additional bootstrap loader code used if the volume is bootable.
Bad cluster file	$BadClus	8	Contains bad clusters for the volume.
Security file	$Secure	9	Contains unique security descriptors for all files within a volume.
Upcase table	$Upcase	10	Converts lowercase characters to matching Unicode uppercase characters.
NTFS extension file	$Extend	11	Used for various optional extensions such as quotas, reparse point data, and object identifiers.
		12–15	Reserved for future use.

NTFS Multiple Data Streams

NTFS supports multiple data *streams*, where the stream name identifies a new data attribute on the file. A handle can be opened to each data stream. A data stream, then, is a unique set of file attributes. Streams have separate opportunistic locks, file locks, and sizes, but common permissions.

This feature enables you to manage data as a single unit. The following is an example of an alternate stream:

```
myfile.dat:stream2
```

A library of files might exist where the files are defined as alternate streams, as in the following example:

```
library:file1
       :file2
       :file3
```

A file can be associated with more than one application at a time, such as Microsoft ® Word and Microsoft © WordPad. For instance, a file structure like the following illustrates file association, but not multiple files:

```
program:source_file
       :doc_file
       :object_file
       :executable_file
```

To create an alternate data stream, at the command prompt, you can type commands such as:

```
echo text>program:source_file
more <program:source_file
```


Important:

When you copy an NTFS file to a FAT volume, such as a floppy disk, data streams and other attributes not supported by FAT are lost.

NTFS Compressed Files

Windows NT/2000 supports compression on individual files, folders, and entire NTFS volumes. Files compressed on an NTFS volume can be read and written by any Windows-based application without first being decompressed by another program. Decompression occurs automatically when the file is read. The file is compressed again when it is closed or saved. Compressed files and folders have an attribute of **C** when viewed in Windows Explorer.

Only NTFS can read the compressed form of the data. When an application such as Microsoft® Word or an operating system command such as **copy** requests access to the file, the compression filter driver decompresses the file before making it available. For example, if you copy a compressed file from another Windows NT/2000–based computer to a compressed folder on your hard disk, the file is decompressed when read, copied, and then recompressed when saved.

This compression algorithm is similar to that used by the Windows 98 application DriveSpace 3, with one important difference — the limited functionality compresses the entire primary volume or logical volume. NTFS allows for the compression of an entire volume, of one or more folders within a volume, or even one or more files within a folder of an NTFS volume.

The compression algorithms in NTFS are designed to support cluster sizes of up to 4 KB. When the cluster size is greater than 4 KB on an NTFS volume, none of the NTFS compression functions are available.

Each NTFS data stream contains information that indicates whether any part of the stream is compressed. Individual compressed buffers are identified by “holes” following them in the information stored for that stream. If there is a hole, NTFS automatically decompresses the preceding buffer to fill the hole.

NTFS provides real-time access to a compressed file, decompressing the file when it is opened and compressing it when it is closed. When writing a compressed file, the system reserves disk space for the uncompressed size. The system gets back unused space as each individual compression buffer is compressed.

NTFS Encrypted Files (Windows 2000 only)

The Encrypting File System (EFS) provides the core file encryption technology used to store encrypted files on NTFS volumes. EFS keeps files safe from intruders who might gain unauthorized physical access to sensitive, stored data (for example, by stealing a portable computer or external disk drive).

EFS uses symmetric key encryption in conjunction with public key technology to protect files and ensure that only the owner of a file can access it. Users of EFS are issued a digital certificate with a public key and a private key pair. EFS uses the key set for the user who is logged on to the local computer where the private key is stored.

Users work with encrypted files and folders just as they do with any other files and folders. Encryption is transparent to the user who encrypted the file; the system automatically decrypts the file or folder when the user accesses. When the file is saved, encryption is reapplied. However, intruders who try to access the encrypted files or folders receive an "Access denied" message if they try to open, copy, move, or rename the encrypted file or folder.

To encrypt or decrypt a folder or file, set the encryption attribute for folders and files just as you set any other attribute. If you encrypt a folder, all files and subfolders created in the encrypted folder are automatically encrypted. It is recommended that you encrypt at the folder level.

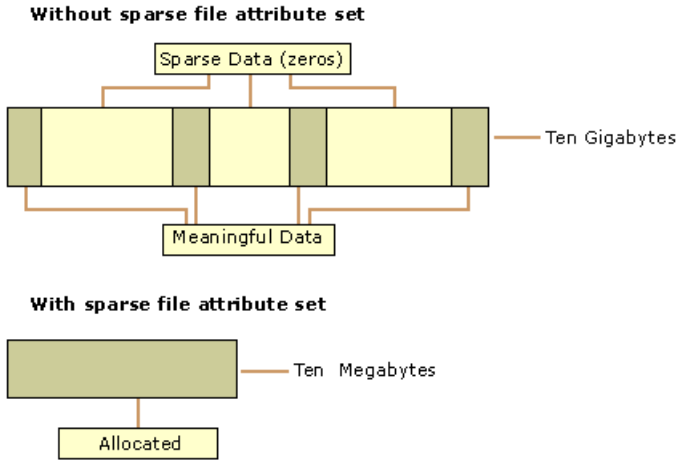
NTFS Sparse Files (Windows 2000 only)

A sparse file has an attribute that causes the I/O subsystem to allocate only meaningful (nonzero) data. Nonzero data is allocated on disk, and non-meaningful data (large strings of data composed of zeros) is not. When a sparse file is read, allocated data is returned as it was stored; non-allocated data is returned, by default, as zeros.

NTFS deallocates sparse data streams and only maintains other data as allocated. When a program accesses a sparse file, the file system yields allocated data as actual data and deallocated data as zeros.

NTFS includes full sparse file support for both compressed and uncompressed files. NTFS handles read operations on sparse files by returning allocated data and sparse data. It is possible to read a sparse file as allocated data and a range of data without retrieving the entire data set, although NTFS returns the entire data set by default.

With the sparse file attribute set, the file system can deallocate data from anywhere in the file and, when an application calls, yield the zero data by range instead of storing and returning the actual data. File system application programming interfaces (APIs) allow for the file to be copied or backed as actual bits and sparse stream ranges. The net result is efficient file system storage and access. Next figure shows how data is stored with and without the sparse file attribute set.



Important:

If you copy or move a sparse file to a FAT or a non-Windows 2000 NTFS volume, the file is built to its originally specified size. If the required space is not available, the operation does not complete.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

Data Integrity and Recoverability with NTFS

Understanding of underlying mechanisms of data storage, organization and data recovery.

NTFS is a recoverable file system that guarantees the consistency of the volume by using standard transaction logging and recovery techniques. In the event of a disk failure, NTFS restores consistency by running a recovery procedure that accesses information stored in a log file. The NTFS recovery procedure is exact, guaranteeing that the volume is restored to a consistent state. Transaction logging requires a very small amount of overhead.

NTFS ensures the integrity of all NTFS volumes by automatically performing disk recovery operations the first time a program accesses an NTFS volume after the computer is restarted following a failure.

NTFS also uses a technique called cluster remapping to minimize the effects of a bad sector on an NTFS volume.

Important:

If either the master boot record (MBR) or boot sector is corrupted, you might not be able to access data on the volume.

Recovering Data with NTFS

NTFS views each I/O operation that modifies a system file on the NTFS volume as a transaction, and manages each one as an integral unit. Once started, the transaction is either completed or, in the event of a disk failure, rolled back (such as when the NTFS volume is returned to the state it was in before the transaction was initiated).

To ensure that a transaction can be completed or rolled back, NTFS records the suboperations of a transaction in a log file before they are written to the disk. When a complete transaction is recorded in the log file, NTFS performs the suboperations of the transaction on the volume cache. After NTFS updates the cache, it commits the transaction by recording in the log file that the entire transaction is complete.

Once a transaction is committed, NTFS ensures that the entire transaction appears on the volume, even if the disk fails. During recovery operations, NTFS redoes each committed transaction found in the log file. Then NTFS locates the transactions in the log file that were not committed at the time of the system failure and undoes each transaction suboperation recorded in the log file. Incomplete modifications to the volume are prohibited.

NTFS uses the Log File service to log all redo and undo information for a transaction. NTFS uses the redo information to repeat the transaction. The undo information enables NTFS to undo transactions that are not complete or that have an error.

Important:

NTFS uses transaction logging and recovery to guarantee that the volume structure is not corrupted. For this reason, all system files remain accessible after a system failure. However, user data can be lost because of a system failure or a bad sector.

Cluster Remapping

In the event of a bad-sector error, NTFS implements a recovery technique called cluster remapping. When Windows 2000 detects a bad-sector, NTFS dynamically remaps the cluster containing the bad sector and allocates a new cluster for the data. If the error occurred during a read, NTFS returns a read error to the calling program, and the data is lost. If the error occurs during a write, NTFS writes the data to the new cluster, and no data is lost.

NTFS puts the address of the cluster containing the bad sector in its bad cluster file so the bad sector is not reused.

Important:

Cluster remapping is *not* a backup alternative. Once errors are detected, the disk should be monitored closely and replaced if the defect list grows. This type of error is displayed in the Event Log.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

File System (FAT)

Understanding of underlying mechanisms of data storage, organization and data recovery.

The FAT file system is a simple file system originally designed for small disks and simple folder structures. The FAT file system is named for its method of organization, the File Allocation Table, which resides at the beginning of the volume. To protect the volume, two copies of the table are kept, in case one becomes damaged. In addition, the file allocation tables and the root folder must be stored in a fixed location so that the files needed to start the system can be correctly located.

A volume formatted with the FAT file system is allocated in clusters. The default cluster size is determined by the size of the volume. For the FAT file system, the cluster number must fit in 16 bits and must be a power of two.

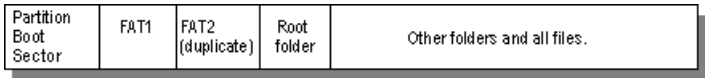


Figure 79: FAT file system volume organization

See the next sections for more information about FAT:

- *FAT Partition Boot Sector* on page 156
- *FAT File Allocation Table* on page 158
- *FAT Root Folder* on page 158
- *FAT Folder Structure* on page 159
- *FAT32 Features* on page 160

Main differences between FAT12, FAT16, FAT32

- FAT12 file system contains 1.5 bytes per cluster within the file allocation table.
- FAT16 file system contains 2 bytes per cluster within the file allocation table.
- FAT32 file system includes 4 bytes per cluster within the file allocation table.

FAT Partition Boot Sector

Understanding of underlying mechanisms of data storage, organization and data recovery.

The Partition Boot Sector contains information that the file system uses to access the volume. On x86-based computers, the Master Boot Record use the Partition Boot Sector on the system partition to load the operating system kernel files.

Next table describes the fields in the Partition Boot Sector for a volume formatted with the FAT file system.

Table 5: System ID field description

Byte Offset (in hex)	Field Length	Sample Value	Meaning
00	3 bytes	EB 3C 90	Jump instruction
03	8 bytes	MSDOS5.0	OEM Name in text
0B	25 bytes		BIOS Parameter Block
24	26 bytes		Extended BIOS Parameter Block
3E	448 bytes		Bootstrap code
1FE	2 bytes	0x55AA	End of sector marker

Table 6: BIOS Parameter Block and Extended BIOS Parameter Block Fields

Byte Offset	Field Length	Sample Value	Meaning
0x0B	WORD	0x0002	Bytes per Sector. The size of a hardware sector. For most disks in use in the United States, the value of this field is 512.
0x0D	BYTE	0x08	Sectors Per Cluster. The number of sectors in a cluster. The default cluster size for a volume depends on the volume size and the file system.
0x0E	WORD	0x0100	Reserved Sectors. The number of sectors from the Partition Boot Sector to the start of the first file allocation table, including the Partition Boot Sector. The minimum value is 1. If the value is greater than 1, it means that the bootstrap code is too long to fit completely in the Partition Boot Sector.
0x10	BYTE	0x02	Number of file allocation tables (FATs). The number of copies of the file allocation table on the volume. Typically, the value of this field is 2.
0x11	WORD	0x0002	Root Entries. The total number of file name entries that can be stored in the root folder of the volume. One entry is always used as a Volume Label. Files with long filenames use up multiple entries per file. Therefore, the largest number of files in the root folder is typically 511, but you will run out of entries sooner if you use long filenames.
0x13	WORD	0x0000	Small Sectors. The number of sectors on the volume if the number fits in 16 bits (65535). For volumes larger than 65536 sectors, this field has a value of 0 and the Large Sectors field is used instead.
0x15	BYTE	0xF8	Media Type. Provides information about the media being used. A value of 0xF8 indicates a hard disk.
0x16	WORD	0xC900	Sectors per file allocation table (FAT). Number of sectors occupied by each of the file allocation tables on the volume. By using this information, together with the Number of FATs and Reserved Sectors, you can compute where the root folder begins. By using the number of entries in the root folder, you can also compute where the user data area of the volume begins.
0x18	WORD	0x3F00	Sectors per Track. The apparent disk geometry in use when the disk was low-level formatted.
0x1A	WORD	0x1000	Number of Heads. The apparent disk geometry in use when the disk was low-level formatted.
0x1C	DWORD	3F 00 00 00	Hidden Sectors. Same as the Relative Sector field in the Partition Table.
0x20	DWORD	51 42 06 00	Large Sectors. If the Small Sectors field is zero, this field contains the total number of sectors in the volume. If Small Sectors is nonzero, this field contains zero..
0x24	BYTE	0x80	Physical Disk Number. This is related to the BIOS physical disk number. Floppy drives are numbered starting with 0x00 for the A disk. Physical hard disks are numbered starting with 0x80. The value is typically 0x80 for hard disks, regardless of how many physical disk drives exist, because the value is only relevant if the device is the startup disk.
0x25	BYTE	0x00	Current Head. Not used by the FAT file system.
0x26	BYTE	0x29	Signature. Must be either 0x28 or 0x29 in order to be recognized by Windows NT.
0x27	4 bytes	CE 13 46 30	Volume Serial Number. A unique number that is created when you format the volume.
0x2B	11 bytes	NO NAME	Volume Label. This field was used to store the volume label, but the volume label is now stored as special file in the root directory.

Byte Offset	Field Length	Sample Value	Meaning
0x36	8 bytes	FAT16	System ID. Either FAT12 or FAT16, depending on the format of the disk.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

FAT File Allocation Table

Understanding of underlying mechanisms of data storage, organization and data recovery.

The FAT file system is named for its method of organization, the file allocation table, which resides at the beginning of the volume. To protect the volume, two copies of the table are kept, in case one becomes damaged. In addition, the file allocation tables must be stored in a fixed location so that the files needed to start the system can be correctly located.

The file allocation table contains the following types of information about each cluster on the volume (see example below for FAT16):

- Unused (0x0000)
- Cluster in use by a file
- Bad cluster (0xFFF7)
- Last cluster in a file (0xFFF8-0xFFFF)

There is no organization to the FAT folder structure, and files are given the first available location on the volume. The starting cluster number is the address of the first cluster used by the file. Each cluster contains a pointer to the next cluster in the file, or an indication (0xFFFF) that this cluster is the end of the file. These links and end of file indicators are shown below.

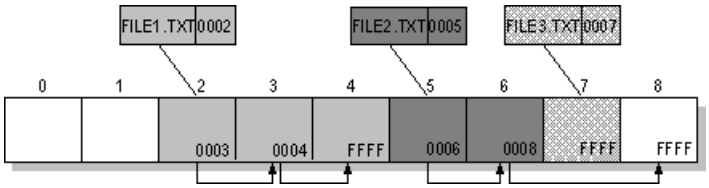


Figure 80: Example of File Allocation Table

This illustration shows three files. The file File1.txt is a file that is large enough to use three clusters. The second file, File2.txt, is a fragmented file that also requires three clusters. A small file, File3.txt, fits completely in one cluster. In each case, the folder entry (see *folder entry* for details) points to the first cluster of the file.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

FAT Root Folder

Understanding of underlying mechanisms of data storage, organization and data recovery.

The root folder contains an entry for each file and folder on the root. The only difference between the root folder and other folders is that the root folder is on a specified location on the disk and has a fixed size (512 entries for a hard disk, number of entries on a floppy disk depends on the size of the disk).

See *FAT Folder Structure* on page 159 topic for details about folder organization.

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

FAT Folder Structure

Understanding of underlying mechanisms of data storage, organization and data recovery.

Folders have set of 32-byte *Folder Entries* for each file and sub-folder contained in the folder (see example figure below).

The *Folder Entry* includes the following information:

- Name (eight-plus-three characters)
- Attribute byte (8 bits worth of information, described later in this section)
- Create time (24 bits)
- Create date (16 bits)
- Last access date (16 bits)
- Last modified time (16 bits)
- Last modified date (16 bits.)
- Starting cluster number in the file allocation table (16 bits)
- File size (32 bits)

There is no organization to the FAT folder structure, and files are given the first available location on the volume. The starting cluster number is the address of the first cluster used by the file. Each cluster contains a pointer to the next cluster in the file, or an indication (0xFFFF) that this cluster is the end of the file. See *File Allocation Table* for details.

The information in the folder is used by all operating systems that support the FAT file system. In addition, Windows NT can store additional time stamps in a FAT folder entry. These time stamps show when the file was created or last accessed and are used principally by POSIX applications.

Because all entries in a folder are the same size, the attribute byte for each entry in a folder describes what kind of entry it is. One bit indicates that the entry is for a sub folder, while another bit marks the entry as a volume label. Normally, only the operating system controls the settings of these bits.

A FAT file has four attributes bits that can be turned on or off by the user — archive file, system file, hidden file, and read-only file.

File names on FAT Volumes

Beginning with Windows NT 3.5, files created or renamed on FAT volumes use the attribute bits to support long file names in a way that does not interfere with how MS-DOS or OS/2 accesses the volume. Whenever a user creates a file with a long file name, Windows creates an eight-plus-three name for the file. In addition to this conventional entry, Windows creates one or more secondary folder entries for the file, one for each 13 characters in the long file name. Each of these secondary folder entries stores a corresponding part of the long file name in Unicode. Windows sets the volume, read-only, system, and hidden file attribute bits of the secondary folder entry to mark it as part of a long file name. MS-DOS and OS/2 generally ignore folder entries with all four of these attribute bits set, so these entries are effectively invisible to these operating systems. Instead, MS-DOS and OS/2 access the file by using the conventional eight-plus-three file name contained in the folder entry for the file.

Figure below shows all of the folder entries for the file Thequi~1.fox, which has a long name of The quick `brown.fox`. The long name is in Unicode, so each character in the name uses two bytes in the folder entry. The attribute field for the long name entries has the value 0x0F. The attribute field for the short name is 0x20.

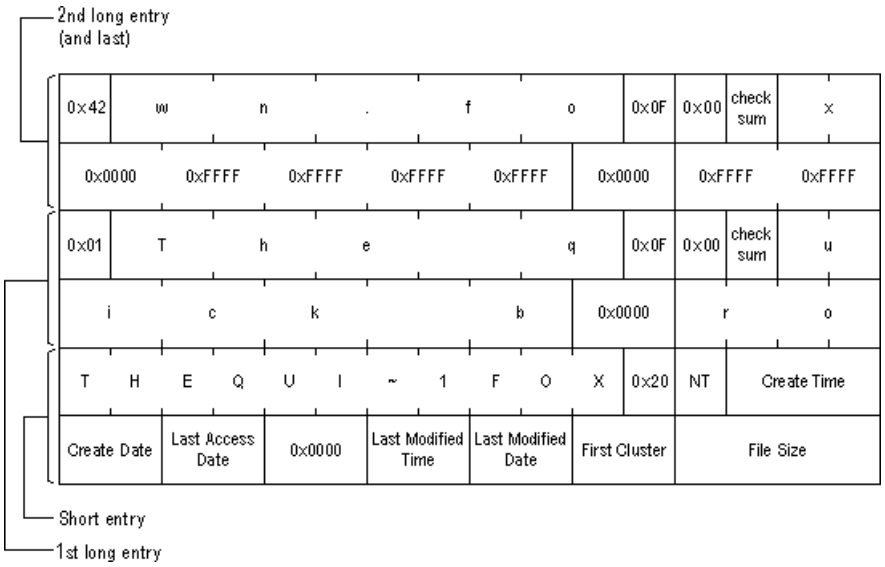


Figure 81: Example of Folder Entries for the long file name

Tip:

For more detailed information see resource kits on Microsoft's web site *http://www.microsoft.com/windows/reskits/webresources/default.asp* or Microsoft Developers Network (MSDN) *http://msdn.microsoft.com*

FAT32 Features

Understanding of underlying mechanisms of data storage, organization and data recovery.

File System Specifications

FAT32 is a derivative of the File Allocation Table (FAT) file system that supports drives with over 2GB of storage. Because FAT32 drives can contain more than 65,526 clusters, smaller clusters are used than on large FAT16 drives. This method results in more efficient space allocation on the FAT32 drive.

The largest possible file for a FAT32 drive is 4GB minus 2 bytes.

The FAT32 file system includes four bytes per cluster within the file allocation table. Note that the high 4 bits of the 32-bit values in the FAT32 file allocation table are reserved and are not part of the cluster number.

Boot Sector and Bootstrap Modifications

Modifications	Description
Reserved Sectors	FAT32 drives contain more reserved sectors than FAT16 or FAT12 drives. The number of reserved sectors is usually 32, but can vary.
Boot Sector Modifications	Because a FAT32 BIOS Parameter Block (BPB), represented by the ***BPB*** structure, is larger than a standard BPB, the boot record on FAT32 drives is greater than 1 sector. In addition, there is a sector in the reserved area on FAT32 drives that contains values for the count of free clusters and the cluster number of the most recently allocated cluster. These values are members of the ***BIGFATBOOTFSINFO*** structure which is contained within this sector. These additional fields allow the system to initialize the values without having to read the entire file allocation table.
Root Directory	The root directory on a FAT32 drive is not stored in a fixed location as it is on FAT16 and FAT12 drives. On FAT32 drives, the root directory is an ordinary cluster chain. The **A_BF_BPB_RootDirStrtClus** member in the **BPB** structure contains the number of the first cluster in the root directory. This allows the root directory to grow as needed. In addition, the **BPB_RootEntries** member of **BPB** is ignored on a FAT32 drive.

Modifications	Description
Sectors Per FAT	The **A_BF_BPB_SectorsPerFAT** member of ***BPB*** is *always* zero on a FAT32 drive. Additionally, the **A_BF_BPB_BigSectorsPerFat** and **A_BF_BPB_BigSectorsPerFatHi** members of the updated **BPB** provide equivalent information for FAT32 media.

BPB (FAT32)

The BPB for FAT32 drives is an extended version of the FAT16/FAT12 BPB. It contains identical information to a standard BPB, but also includes several extra fields for FAT32 specific information.

This structure is implemented in Windows OEM Service Release 2 and later.

```
A_BF_BPB    STRUC
    A_BF_BPB_BytesPerSector       DW    ?
    A_BF_BPB_SectorsPerCluster    DB    ?
    A_BF_BPB_ReservedSectors      DW    ?
    A_BF_BPB_NumberOfFATs         DB    ?
    A_BF_BPB_RootEntries          DW    ?
    A_BF_BPB_TotalSectors         DW    ?
    A_BF_BPB_MediaDescriptor      DB    ?
    A_BF_BPB_SectorsPerFAT        DW    ?
    A_BF_BPB_SectorsPerTrack      DW    ?
    A_BF_BPB_Heads                DW    ?
    A_BF_BPB_HiddenSectors        DW    ?
    A_BF_BPB_HiddenSectorsHigh    DW    ?
    A_BF_BPB_BigTotalSectors      DW    ?
    A_BF_BPB_BigTotalSectorsHigh  DW    ?
    A_BF_BPB_BigSectorsPerFat     DW    ?
    A_BF_BPB_BigSectorsPerFatHi   DW    ?
    A_BF_BPB_ExtFlags             DW    ?
    A_BF_BPB_FS_Version           DW    ?
    A_BF_BPB_RootDirStrtClus      DW    ?
    A_BF_BPB_RootDirStrtClusHi    DW    ?
    A_BF_BPB_FSInfoSec            DW    ?
    A_BF_BPB_BkUpBootSec          DW    ?
    A_BF_BPB_Reserved             DW    6 DUP (?)
A_BF_BPB    ENDS
```

A_BF_BPB_BytesPerSector

The number of bytes per sector.

A_BF_BPB_SectorsPerCluster

The number of sectors per cluster.

A_BF_BPB_ReservedSectors

The number of reserved sectors, beginning with sector 0.

A_BF_BPB_NumberOfFATs

The number of File Allocation Tables.

A_BF_BPB_RootEntries

This member is ignored on FAT32 drives.

A_BF_BPB_TotalSectors

The size of the partition, in sectors.

A_BF_BPB_MediaDescriptor

The media descriptor. Values in this member are identical to standard BPB.

A_BF_BPB_SectorsPerFAT

The number of sectors per FAT.

Note: This member will always be zero in a FAT32 BPB. Use the values from **A_BF_BPB_BigSectorsPerFat** and **A_BF_BPB_BigSectorsPerFatHi** for FAT32 media.

A_BF_BPB_SectorsPerTrack

The number of sectors per track.

A_BF_BPB_Heads

The number of read/write heads on the drive.

A_BF_BPB_HiddenSectors

The number of hidden sectors on the drive.

A_BF_BPB_HiddenSectorsHigh

The high word of the hidden sectors value.

A_BF_BPB_BigTotalSectors

The total number of sectors on the FAT32 drive.

A_BF_BPB_BigTotalSectorsHigh

The high word of the FAT32 total sectors value.

A_BF_BPB_BigSectorsPerFat

The number of sectors per FAT on the FAT32 drive.

A_BF_BPB_BigSectorsPerFatHi

The high word of the FAT32 sectors per FAT value.

A_BF_BPBExtFlags

Flags describing the drive. Bit 8 of this value indicates whether or not information written to the active FAT will be written to all copies of the FAT. The low 4 bits of this value contain the 0-based FAT number of the Active FAT, but are only meaningful if bit 8 is set. This member can contain a combination of the following values.

Value	Description
BGBPB_F_ActiveFATMask (000Fh)	Mask for low four bits.
BGBPB_F_NoFATMirror (0080h)	Mask indicating FAT mirroring state. If set, FAT mirroring is disabled. If clear, FAT mirroring is enabled.

* Bits 4-6 and 8-15 are reserved.

A_BF_BPB_FS_Version

The file system version number of the FAT32 drive. The high byte represents the major version, and the low byte represents the minor version.

A_BF_BPB_RootDirStrtClus

The cluster number of the first cluster in the FAT32 drive's root directory.

A_BF_BPB_RootDirStrtClusHi

The high word of the FAT32 starting cluster number.

A_BF_BPB_FSInfoSec

The sector number of the file system information sector. The file system info sector contains a ***BIGFATBOOTFSINFO*** structure. This member is set to 0FFFFh if there is no FSINFO sector. Otherwise, this value must be non-zero and less than the reserved sector count.

A_BF_BPB_BkUpBootSec

The sector number of the backup boot sector. This member is set to 0FFFFh if there is no backup boot sector. Otherwise, this value must be non-zero and less than the reserved sector count.

A_BF_BPB_Reserved

Reserved member.

BIGFATBOOTFSINFO (FAT32)

Contains information about the file system on a FAT32 volume. This structure is implemented in Windows OEM Service Release 2 and later.

```
BIGFATBOOTFSINFO STRUC
  bfFSInf_Sig               DD    ?
  bfFSInf_free_clus_cnt     DD    ?
  bfFSInf_next_free_clus    DD    ?
  bfFSInf_resvd             DD    3 DUP (?)
BIGFATBOOTFSINFO ENDS
```

bfFSInf_Sig

The signature of the file system information sector. The value in this member is FSINFOSIG (0x61417272L).

bfFSInf_free_clus_cnt

The count of free clusters on the drive. Set to -1 when the count is unknown.

bfFSInf_next_free_clus

The cluster number of the cluster that was most recently allocated.

bfFSInf_resvd

Reserved member.

FAT Mirroring

On all FAT drives, there may be multiple copies of the FAT. If an error occurs reading the primary copy, the file system will attempt to read from the backup copies. On FAT16 and FAT12 drives, the first FAT is always the primary copy and any modifications will automatically be written to all copies. However, on FAT32 drives, FAT mirroring can be disabled and a FAT other than the first one can be the primary (or "active") copy of the FAT.

Mirroring is enabled by clearing bit 0x0080 in the **extdpb_flags** member of a FAT32 Drive Parameter Block (DPB) structure, ***DPB***.

Mirroring	Description
When Enabled (bit 0x0080 clear)	With mirroring enabled, whenever a FAT sector is written, it will also be written to every other FAT. Also, a mirrored FAT sector can be read from any FAT. A FAT32 drive with multiple FATs will behave the same as FAT16 and FAT12 drives with multiple FATs. That is, the multiple FATs are backups of each other.
When Disabled (bit 0x0080 set)	With mirroring disabled, only one of the FATs is active. The active FAT is the one specified by bits 0 through 3 of the **extdpb_flags** member of ***DPB***. The other FATs are ignored. Disabling mirroring allows better handling of a drive with a bad sector in one of the FATs. If a bad sector exists, access to the damaged FAT can be completely disabled. Then, a new FAT can be built in one of the inactive FATs and then made accessible by changing the active FAT value in **extdpb_flags**.

DPB (FAT32)

The DPB was extended to include FAT32 information. Changes are effective for Windows 95 OEM Service Release 2 and later.

```
DPB STRUC
    dpb_drive             DB    ?
    dpb_unit              DB    ?
    dpb_sector_size       DW    ?
    dpb_cluster_mask      DB    ?
    dpb_cluster_shift     DB    ?
    dpb_first_fat         DW    ?
    dpb_fat_count         DB    ?
```

```
    dpb_root_entries     DW    ?
    dpb_first_sector     DW    ?
    dpb_max_cluster      DW    ?
    dpb_fat_size         DW    ?
    dpb_dir_sector       DW    ?
    dpb_reserved2        DD    ?
    dpb_media            DB    ?
ifdef NOTFAT32
    dpb_first_access     DB    ?
else
    dpb_reserved         DB    ?
endif
    dpb_reserved3        DD    ?
    dpb_next_free        DW    ?
    dpb_free_cnt         DW    ?
ifndef NOTFAT32
    extdpb_free_cnt_hi   DW    ?
    extdpb_flags         DW    ?
    extdpb_FSInfoSec     DW    ?
    extdpb_BkUpBootSec   DW    ?
    extdpb_first_sector  DD    ?
    extdpb_max_cluster   DD    ?
    extdpb_fat_size      DD    ?
    extdpb_root_clus     DD    ?
    extdpb_next_free     DD    ?
endif
DPB ENDS
```

dpb_drive

The drive number (0 = A, 1 = B, and so on).

dpb_unit

Specifies the unit number. The device driver uses the unit number to distinguish the specified drive from the other drives it supports.

dpb_sector_size

The size of each sector, in bytes.

dpb_cluster_mask

The number of sectors per cluster minus 1.

dpb_cluster_shift

The number of sectors per cluster, expressed as a power of 2.

dpb_first_fat

The sector number of the first sector containing the file allocation table (FAT).

dpb_fat_count

The number of FATs on the drive.

dpb_root_entries

The number of entries in the root directory.

dpb_first_sector

The sector number of the first sector in the first cluster.

dpb_max_cluster

The number of clusters on the drive plus 1. This member is undefined for FAT32 drives.

dpb_fat_size

The number of sectors occupied by each FAT. The value of zero indicates a FAT32 drive. Use the value in **extdpb_fat_size** instead.

dpb_dir_sector

The sector number of the first sector containing the root directory. This member is undefined for FAT32 drives.

dpb_reserved2

Reserved member. Do not use.

dpb_media

Specifies the media descriptor for the medium in the specified drive.

reserved

Reserved member. Do not use.

dpb_first_access

Indicates whether the medium in the drive has been accessed. This member is initialized to -1 to force a media check the first time this DPB is used.

dpb_reserved3

Reserved member. Do not use.

dpb_next_free

The cluster number of the most recently allocated cluster.

dpb_free_cnt

The number of free clusters on the medium. This member is 0FFFFh if the number is unknown.

extdpb_free_cnt_hi

The high word of free count.

extdpb_flags

Flags describing the drive. The low 4 bits of this value contain the 0-based FAT number of the Active FAT. This member can contain a combination of the following values.

Value	Description
BGBPB_F_ActiveFATMask (000Fh)	Mask for low four bits.
BGBPB_F_NoFATMirror (0080h)	Do not mirror active FAT to inactive FATs.

Bits 4-6 and 8-15 are reserved.

extdpb_FSInfoSec

The sector number of the file system information sector. This member is set to 0FFFFh if there is no FSINFO sector. Otherwise, this value must be non-zero and less than the reserved sector count.

extdpb_BkUpBootSec

The sector number of the backup boot sector. This member is set to 0FFFFh if there is no backup boot sector. Otherwise, this value must be non-zero and less than the reserved sector count.

extdpb_first_sector

The first sector of the first cluster.

extdpb_max_cluster

The number of clusters on the drive plus 1.

extdpb_fat_size

The number of sectors occupied by the FAT.

extdpb_root_clus

The cluster number of the first cluster in the root directory.

extdpb_next_free

The number of the cluster that was most recently allocated.

Partition Types

The following are all the valid partition types and their corresponding values for use in the **Part_FileSystem** member of the ***s_partition*** structure.

Table 7: Partition Types

Value	Description
PART_UNKNOWN (00h)	Unknown
PART_DOS2_FAT (01h)	12-bit FAT
PART_DOS3_FAT (04h)	16-bit FAT. Partitions smaller than 32MB.
PART_EXTENDED (05h)	Extended MS-DOS Partition
PART_DOS4_FAT (06h)	16-bit FAT. Partitions larger than or equal to 32MB.
PART_DOS32 (0Bh)	32-bit FAT. Partitions up to 2047GB.
PART_DOS32X (0Ch)	Same as PART_DOS32 (0Bh), but uses Logical Block Address Int 13h extensions.
PART_DOSX13 (0Eh)	Same as PART_DOS4_FAT (06h), but uses Logical Block Address Int 13h extensions.
PART_DOSX13X (0Fh)	Same as PART_EXTENDED (05h), but uses Logical Block Address Int 13h extensions.

s_partition (FAT32)

```
s_partition    STRUC
    Part_BootInd        DB    ?
    Part_FirstHead      DB    ?
    Part_FirstSector    DB    ?
    Part_FirstTrack     DB    ?
    Part_FileSystem     DB    ?
    Part_LastHead       DB    ?
    Part_LastSector     DB    ?
    Part_LastTrack      DB    ?
    Part_StartSector    DD    ?
    Part_NumSectors     DD    ?
s_partition    ENDS
```

Part_BootInd

Specifies whether the partition is bootable or not. This value could be set to PART_BOOTABLE (80h), or PART_NON_BOOTABLE(00h). The first partition designated as PART_BOOTABLE is the boot partition. All others are not. Setting multiple partitions to PART_BOOTABLE will result in boot errors.

Part_FirstHead

The first head of this partition. This is a 0-based number representing the offset from the beginning of the disk. The partition includes this head.

Part_FirstSector

The first sector of this partition. This is a 1-based, 6-bit number representing the offset from the beginning of the disk. The partition includes this sector. Bits 0 through 5 specify the 6-bit value; bits 6 and 7 are used with the **Part_FirstTrack** member.

Part_FirstTrack

The first track of this partition. This is an inclusive 0-based, 10-bit number that represents the offset from the beginning of the disk. The high 2 bits of this value are specified by bits 6 and 7 of the **Part_FirstSector** member.

PartFileSystem

Specifies the file system for the partition.

Table 8: Acceptable values

Value	Description
PART_UNKNOWN(00h)	Unknown.
PART_DOS2_FAT(01h)	12-bit FAT.
PART_DOS3_FAT(04h)	16-bit FAT. Partition smaller than 32MB.
PART_EXTENDED(05h)	Extended MS-DOS Partition.
PART_DOS4_FAT(06h)	16-bit FAT. Partition larger than or equal to 32MB.
PART_DOS32(0Bh)	32-bit FAT. Partition up to 2047GB.
PART_DOS32X(0Ch)	Same as PART_DOS32(0Bh), but uses Logical Block Address **Int 13h** extensions.
PART_DOSX13(0Eh)	Same as PART_DOS4_FAT(06h), but uses Logical Block Address **Int 13h** extensions.
PART_DOSX13X(0Fh)	Same as PART_EXTENDED(05h), but uses Logical Block Address **Int 13h** extensions.

Part_LastHead

The last head of the partition. This is a 0-based number that represents the offset from the beginning of the disk. The partition includes the head specified by this member.

Part_LastSector

The last sector of this partition. This is a 1-based, 6-bit number representing offset from the beginning of the disk. The partition includes the sector specified by this member. Bits 0 through 5 specify the 6-bit value; bits 6 and 7 are used with the **Part_LastTrack** member.

Part_LastTrack

The last track of this partition. This is a 0-based, 10-bit number that represents offset from the beginning of the disk. The partition includes this track. The high 2 bits of this value are specified by bits 6 and 7 of the **Part_LastSector** member.

Part_StartSector

Specifies the 1-based number of the first sector on the disk. This value may not be accurate for extended partitions. Use the **Part_FirstSector** value for extended partitions.

Part_NumSectors

The 1-based number of sectors in the partition.

Note:

Values for head and track are 0-based. Sector values are 1-based. This structure is implemented in Windows OEM Service Release 2 and later.

Extended File System (exFAT)

Understanding of underlying mechanisms of data storage, organization and data recovery.

Extended File System (exFAT) is a successor of FAT family of file systems (FAT12/16/32). It has similar design though renders many significant improvements:

- Larger volume and file size limits
- Native Unicode file names
- Bigger boot area allowing a larger boot code
- Better performance
- Time zone offset support
- OEM parameters support

exFAT vs. FAT32 Comparison

Feature	FAT32	exFAT
Maximum Volume Size	8 TB*	128 PB
Maximum File Size	4 GB	16 EB
Maximum Cluster Size	32 KB **	32 MB
Maximum Cluster Count	228	232
Maximum File Name Length	255	255
Date/Time resolution	2 s	10 ms
MBR Partition Type Identifier	0x0B, 0x0C	0x07

Notice: Windows cannot format FAT32 volumes bigger than 32GB, though itsupports larger volumes created by third party implementations; 16 TB is the maximum volume size if formatted with 64KB cluster

Notice: According to Microsoft KB184006 clusters cannot be 64KB or larger, though some third party implementations support up to 64KB.

Volume Layout

Understanding of underlying mechanisms of data storage, organization and data recovery.

Offset, sectors	Size, sectors	Block	Comments
Main Boot Region			
0	1	Boot Sector	
1	8	Extended Boot Sectors	
9	1	OEM Parameters	
10	1	Reserved	
11	1	Boot Checksum	
Backup Boot Region			
12	1	Boot Sector	
13	8	Extended Boot Sectors	
21	1	OEM Parameters	
22	1	Reserved	
23	1	Boot Checksum	
FAT Region			

Offset, sectors	Size, sectors	Block	Comments
24	FatOffset - 24	FAT Alignment	Boot Sectors contain FatOffset
FatOffset	FatLength	First FAT	Boot Sectors contain FatOffset and FatLength
FatOffset + FatLength	FatLength	Second FAT	For TexFAT only
Data Region			
FatOffset + FatLength * NumberOfFats	ClusterHeapOffset – (FatOffset + FatLength * NumberOfFats)	Cluster Heap Alignment	
ClusterHeapOffset	ClusterCount * 2^SectorsPerClusterShift	Cluster Heap	
ClusterHeapOffset + ClusterCount * 2^SectorsPerClusterShift	VolumeLength – (ClusterHeapOffset + ClusterCount * 2^SectorsPerClusterShift)	Excess Space	

Navigate to detailed volume specification using following links:

- *Boot Sector* on page 169
- *Extended Boot Sector* on page 170
- *OEM Parameters* on page 171
- *Boot Checksum* on page 171
- *File Allocation Table (FAT)* on page 172

Boot Sector

Offset	Size	Description	Comments
0 (0x00)	3	JumpBoot	0xEB7690
3 (0x03)	8	FileSystemName	"EXFAT "
11 (0x0B)	53	MustBeZero	
64 (0x40)	8	PartitionOffset	In sectors; if 0, shall be ignored
72 (0x48)	8	VolumeLength	Size of exFAT volume in sectors
80 (0x50)	4	FatOffset	In sectors
84 (0x54)	4	FatLength	In sectors. May exceed the required space in order to align the second FAT
88 (0x58)	4	ClusterHeapOffset	In sectors
92 (0x5C)	4	ClusterCount	2^32-11 is the maximum number of clusters could be described
96 (0x60)	4	RootDirectoryCluster	
100 (0x64)	4	VolumeSerialNumber	

Offset	Size	Description	Comments
104 (0x68)	2	FileSystemRevision	as MAJOR.minor, major revision is high byte, minor is low byte; currently 01.00
106 (0x6A)	2	VolumeFlags (see below)	
108 (0x6C)	1	BytesPerSectorShift	Power of 2. Minimum 9 (512 bytes per sector), maximum 12 (4096 bytes per sector)
109 (0x6D)	1	SectorsPerCluster Shift	Power of 2. Minimum 0 (1 sector per cluster), maximum 25 – BytesPerSectorShift, so max cluster size is 32 MB
110 (0x6E)	1	NumberOfFats	2 is for TexFAT only
111 (0x6F)	1	DriveSelect	Extended INT 13h drive number; typically 0x80
112 (0x70)	1	PercentInUse	0..100 – percentage of allocated clusters rounded down to the integer 0xFF – percentage is not available
113 (0x71)	7	Reserved	
120 (0x78)	390	BootCode	
510 (0x1FE)	2	BootSignature	0xAA55
512 (0x200)	2^BytesPerSectorShift - 512	ExcessSpace	Not used

Table 9: Volume Flags

Offset	Size	Field
0	1	ActiveFat 0 - First FAT and Allocation Bitmap are active, 1 - Second .
1	1	VolumeDirty (0-clean, 1-dirty)
2	1	MediaFailure (0 – no failures reported or they already marked as BAD clusters) 1- some read/write operations failed)
3	1	ClearToZero (no meaning)
4	12	Reserved

Extended Boot Sector

Offset	Size	Description	Comments
0 (0x00)	2^BytesPerSectorShift - 4	ExtendedBootCode	
2^BytesPerSectorShift - 4	4	ExtendedBootSignature	0xAA550000

Whole sector is used for boot code except last 4 bytes used for signature in each sector. If Extended Boot Sector is not used, it should be filled with 0x00. Extended signature must be preserved.

OEM Parameters

Offset	Size	Description	Comments
0 (0x00)	48	Parameters[0]	
…	…	…	
432 (0x1B0)	48	Parameters[9]	
480 (0x01E0)	2^BytesPerSectorShift - 480	Reserved	

OEM parameters are ignored by Windows but can be used by OEM implementations. OEMs can define their own parameters with unique GUIDs. All unused Parameters fields must be described as unused by GUID_NULL in ParameterType.

This structure must be preserved during exFAT formatting, except in the case of secure wipe.

Table 10: OEM Parameter Record

Offset	Size	Description	Comments
0x00	16	ParameterType	OEM defined GUID , GUID_NULL indicate that parameter value is not used
0x10	32	ParameterValue	OEM specific

```
#define OEM_FLASH_PARAMETER_GUID 0A0C7E46-3399-4021-90C8-FA6D389C4BA2
struct
{
 GUID OemParameterType; //Value is OEM_FLASH_PARAMETER_GUID
 UINT32 EraseBlockSize; //Erase block size in bytes
 UINT32 PageSize;
 UINT32 NumberOfSpareBlocks;
 UINT32 tRandomAccess;  //Random Access Time in nanoseconds
 UINT32 tProgram;             //Program time in nanoseconds
 UINT32 tReadCycle;     //Serial read cycle time in nanoseconds
 UINT32 tWriteCycle;    //Write Cycle time in nanoseconds
 UCHAR Reserved[4];
}
FlashParameters;
```

Boot Checksum

This sector contains a repeating 32-bit checksum of the previous 11 sectors. The checksum calculation excludes VolumeFlags and PercentInUse fields in Boot Sector (bytes 106, 107, 112). The checksum is repeated until the end of the sector. The number of repetitions depends on the size of the sector.

```
UINT32 BootChecksum(const unsigned char data[], int bytes)
{
 UINT32 checksum = 0;

 for (int i = 0; i < bytes; i++)
```

```
  {
   if (i == 106 || i == 107 || i == 112)
    continue;
   checksum = (checksum << 31) | (checksum >> 1) + data[i];
  }
  return checksum;
 }
```

File Allocation Table (FAT)

File Allocation Table (FAT) may contain 1 or 2 FATs, as defined in NumberOfFats field. ActiveFat field in VolumeFlags in the Main Boot Sector determines which FAT is active.

The first cluster is cluster 2, as in FAT32. Each FatEntry represents one cluster

In exFAT, FAT is not used for tracking an allocation; an Allocation Bitmap is used for this purpose. FAT is only used for keeping chains of clusters of fragmented files. If a file is not fragmented, FAT table does not need to be updated. A Stream Extensions Directory Entry should be consulted to determine if the FAT chain is valid or not. If FAT chain is not valid, it does not need to be zeroed.

Offset	Size	Description	Comments
0 (0x00)	4	FatEntry[0]	Media type (should be 0xFFFFFFF8)
4 (0x04)	4	FatEntry[1]	Must be 0xFFFFFFFF
8 (0x08)	4	FatEntry[2]	First cluster
…	…	…	…
(ClusterCount + 1) * 4	4	FatEntry[ClusterCount + 1]	Last cluster
(ClusterCount + 2) * 4	Remainder of sector	ExcessSpace	

Valid values of FAT entries:

0x00000002

ClusterCount +1 (max 0xFFFFFFF6) – next cluster in the chain

0xFFFFFFF7

bad cluster

0xFFFFFFF8

media descriptor

0xFFFFFFFF

end of file (EOF mark)

Value 0x00000000 does not mean the cluster is free, it is an undefined value.

The second FAT table (presents only in TexFAT) is located immediately after the first one and has the same size.

exFAT Directory Structure

Understanding of underlying mechanisms of data storage, organization and data recovery.

exFAT uses tree structure to describe relationship between files and directories. The root of the directory tree is defined by directory located at RootDirectoryCluster. Subdirectories are single-linked to there parents. There is no special (.) and (..) directories pointing to itself and to parent like in FAT16/FAT32.

Each directory consists of a series of directory entries. Directory entries are classified as critical/benign and primary/secondary as follows:

- Primary Directory Entries

- Critical Primary Entries
- Benign Primary Entries
- Secondary Directory Entries
- Critical Secondary Entries
- Benign Secondary Entries

Critical entries are required while benign entries are optional. Primary directory entries correspond to the entries in file system and describe main characteristics. Secondary directory entries extend the metadata associated with a primary directory entry end follow it. A group of primary/secondary entries make up a directory entry set describing a file or directory. The first directory entry in the set is a primary directory entry. All subsequent entries, if any, must be secondary directory entries.

Each directory entry derives from Generica Directory Entry template. Size of directory entry is 32 bytes.

Table 11: Generic Directory Entry Template

Offset	Size	Description	Comments
0 (0x00)	1	EntryType (see below)	
1 (0x01)	19	CustomDefined	
20 (0x14)	4	FirstCluster	0 – no cluster allocation 2..ClusterCount+1 – cluster index
24 (0x18)	8	DataLength	In bytes

Table 12: Enty Types description

Bits	Size	Description	Comments
0-4	5	Code	
5	1	Importance	0 – Critical entry, 1 – Benign entry
6	1	Category	0 – Primary entry, 1 – Secondary entry
7	1	In use status	0 – Not in use, 1 – In use

EntryType can have the following values:

- **0x00** – End Of Directory marker. All other fields in directory entry are invalid. All subsequent directory entries are also End Of Directory markers
- **0x01-0x7F** (InUse = 0). All other fields in this entry are not defined
- **0x81-0xFF** (InUse = 1). Regular record with all fields defined.

Table 13: Generic Primary Directory Entry Template

Offset	Size	Description	Comments
0 (0x00)	1	EntryType	
1 (0x01)	1	SecondaryCount	Number of secondary entries which immediately follow this primary entry and together comprise a directory entry set. Valid value is 0..255

Offset	Size	Description	Comments
2 (0x02)	2	SetChecksum	Checksum of all directory entries in the given set excluding this field. See EntrySetCheckSum().
4 (0x04)	2	GeneralPrimaryFlags (see below)	
6 (0x06)	14	CustomDefined	
20 (0x14)	4	FirstCluster	
24 (0x18)	8	DataLength	

Bits	Size	Description	Comments
0	1	AllocationPossible	0-not possible (FirstCluster and DataLength undefined), 1-possible
1	1	NoFatChain	0-FAT cluster chain is valid 1-FAT cluster chain is not used (contiguous data)
2	14	CustomDefined	

All critical primary directory entries are located in root directory (except file directory entries). Benign primary directory enries are optional. If one benign primary entry is not recognized, all directory entry set is ignored.

```
// data points to directory entry set in memory
UINT16 EntrySetChecksum(const unsigned char data[], int secondaryCount)
{
 UINT16 checksum = 0;
 int bytes = (secondaryCount + 1) * 32;

 for (int i = 0; i < bytes; i++)
 {
  if (i == 2 || i == 3)
   continue;
  checksum = (checksum << 15) | (checksum >> 1) + data[i];
 }
 return checksum;
}
```

exFAT Defined Directory Entries

Understanding of underlying mechanisms of data storage, organization and data recovery.

Main exFAT directory entries defined in table below:

Table 14: Defined Directory Entries list

EntryType	Primary	Critical	Code	Directory Entry Name
0x81	boolean: yes	boolean: yes	1	Allocation Bitmap
0x82	boolean: yes	boolean: yes	2	Up-case Table

EntryType	Primary	Critical	Code	Directory Entry Name
0x83	boolean: yes	boolean: yes	3	Volume Label
0x85	boolean: yes	boolean: yes	5	File
0xA0	boolean: yes	boolean: no	0	Volume GUID
0xA1	boolean: yes	boolean: no	1	TexFAT Padding
0xA2	boolean: yes	boolean: no	2	Windows CE Access Control Table
0xC0	boolean: no	boolean: yes	0	Stream Extension
0xC1	boolean: no	boolean: yes	1	File Name

Read about Directory entries below:

- *Allocation Bitmap Directory Entry* on page 175
- *Up-Case Table Directory Entry* on page 176
- *Volume Label Directory Entry* on page 176
- *File Directory Entry* on page 176
- *Volume GUID Directory Entry* on page 178
- *TexFAT Padding Directory Entry* on page 179
- *Windows CE Access Control Table Directory Entry* on page 179
- *Stream Extension Directory Entry* on page 179
- *File Name Directory Entry* on page 181

Allocation Bitmap Directory Entry

Offset	Size	Description	Comments
0 (0x00)	1	Entry type	0x81
1 (0x01)	1	BitmapFlags (see below)	Indicates which Allocation Bitmap the given entry describes
2 (0x02)	18	Reserved	
20 (0x14)	4	First Cluster	
24 (0x18)	8	Data Length	

Table 15: Bitmap Flags

Bits	Size	Description	Comments
0	1	BitmapIdentifier	0 – 1st bitmap, 1 - 2nd bitmap
1	7	Reserved	

The number of bitmaps and therefore a number of Bitmap Allocation entries is equal to the number of FATs. In case of TexFAT two FATs are used and bit 0 of Flags indicates which bitmap and FAT are referred.

The First Allocation Bitmap shall be used in conjunction with the First FAT and the Second Allocation Bitmap shall be used with the Second FAT. ActiveFat field in Boot Sector defines which FAT and Allocation Bitmap are active.

Bitmap size in bytes must be a number of clusters in the volume divided by 8 and rounded up.

Up-Case Table Directory Entry

Offset	Size	Description	Comments
0 (0x00)	1	Entry type	0x82
1 (0x01)	3	Reserved1	
4 (0x04)	4	TableChecksum	Up-case Table checksum
8 (0x08)	12	Reserved2	
20 (0x14)	4	FirstCluster	
24 (0x18)	8	DataLength	

The checksum is calculated against DataLength bytes of Up-case Table according to the following code:

```
UINT32 UpCaseTableChecksum(const unsigned char data[], int bytes)
{
 UINT32 checksum = 0;

 for (int i = 0; i < bytes; i++)
  checksum = (checksum << 31) | (checksum >> 1) + data[i];

 return checksum;
}
```

Volume Label Directory Entry

Offset	Size	Description	Comments
0 (0x00)	1	Entry type	0x83
1 (0x01)	1	CharacterCount	Length in Unicode characters (max 11)
2 (0x02)	22	VolumeLabel	Unicode string
24 (0x18)	8	Reserved	

If volume is formatted without a label, the Volume Label Entry will be present but Entry Type will be set to 0x03 (not in use).

File Directory Entry

File directory entry describes files and directories. It is a primary critical directory entry and must be immediately followed by 1 Stream Extension directory entry and from 1 to 17 File Name directory entries. Those 3-19 directory entries comprise a directory entry set describing a single file or a directory.

Offset	Size	Description	Comments
0 (0x00)	1	Entry type	0x85
1 (0x01)	1	SecondaryCount	Must be from 2 to 18
2 (0x02)	2	SetChecksum	
4 (0x04)	2	FileAttributes (see below)	
6 (0x06)	2	Reserved1	
8 (0x08)	4	CreateTimestamp	

Offset	Size	Description	Comments
12 (0x0C)	4	LastModifiedTimestamp	
16 (0x10)	4	LastAccessedTimestamp	
20 (0x14)	1	Create10msIncrement	0..199
21 (0x15)	1	LastModified10msIncrement	0..199
22 (0x16)	1	CreateTimezoneOffset	Offset from UTC in 15 min increments
23 (0x17)	1	LastModifiedTimezoneOffset	Offset from UTC in 15 min increments
24 (0x18)	1	LastAccessedTimezoneOffset	Offset from UTC in 15 min increments
25 (0x19)	7	Reserved2	

Table 16: File Attributes

Bits	Size	Description	Comments
0	1	ReadOnly	
1	1	Hidden	
2	1	System	
3	1	Reserved1	
4	1	Directory	
5	1	Archive	
6	10	Reserved2	

Table 17: Timestamp Format

Bits	Size	Description	Comments
0-4	5	Seconds (as number of 2-second intervals)	0..29 29 represents 58 seconds
5-10	6	Minutes	0..59
11-15	5	Hour	0..23
16-20	5	Day	1..31
21-24	4	Month	1..12
25-31	7	Year (as offset from 1980)	0 represents 1980

Timestamp format records seconds as 2 seconds intervals, so 10ms increments are used to increase precision from 2 seconds to 10 milliseconds. The valid values are from 0 to 199 in 10ms intervals which are added to correspondent timestamp. Timestamp is recorded in local time.

Time zone offset is expressed in 15 minutes increments.

Table 18: Time Zone Offset Tablet

TimezoneOffset field	TZ Offset	Time Zone	Comments
128 (0x80)	UTC	Greenwich Standard Time	
132 (0x84)	UTC+01:00	Central Europe Time	
136 (0x88)	UTC+02:00	Eastern Europe Standard Time	
140 (0x8C)	UTC+03:00	Moscow Standard Time	
144 (0x90)	UTC+04:00	Arabian Standard Time	
148 (0x94)	UTC+05:00	West Asia Standard Time	
152 (0x98)	UTC+06:00	Central Asia Standard Time	
156 (0x9C)	UTC+07:00	North Asia Standard Time	
160 (0xA0)	UTC+08:00	North Asia East Standard Time	
164 (0xA4)	UTC+09:00	Tokyo Standard Time	
168 (0xA8)	UTC+10:00	West Pacific Standard Time	
172 (0xAC)	UTC+11:00	Central Pacific Standard Time	
176 (0xB0)	UTC+12:00	New Zealand Standard Time	
180 (0xB4)	UTC+13:00	Tonga Standard Time	
208 (0xD0)	UTC-12:00	Dateline Standard Time	
212 (0xD4)	UTC-11:00	Samoa Standard Time	
216 (0xD8)	UTC-10:00	Hawaii Standard Time	
220 (0xDC)	UTC-09:00	Alaska Standard Time	
224 (0xE0)	UTC-08:00	Pacific Standard Time	
228 (0xE4)	UTC-07:00	Mountain Standard Time	
232 (0xE8)	UTC-06:00	Central Standard Time	
236 (0xEC)	UTC-05:00	Eastern Standard Time	
240 (0xF0)	UTC-04:00	Atlantic Standard time	
242 (0xF2)	UTC-03:30	Newfoundland Standard Time	
244 (0xF4)	UTC-03:00	Greenland Standard Time	
248 (0xF8)	UTC-02:00	Mid-Atlantic Standard Time	
252 (0xFC)	UTC-01:00	Azores Standard Time	

Volume GUID Directory Entry

In following table presented a benign primary directory entry and may not present in a file system.

Offset	Size	Description	Comments
0 (0x00)	1	EntryType	0xA0
1 (0x01)	1	SecondaryCount	Must be 0x00
2 (0x02)	2	SetChecksum	
4 (0x04)	2	GeneralPrimaryFlags (See below)	
6 (0x06)	16	VolumeGuid	All values are valid except null GUID {00000000-0000-0000-0000-00000000000
22 (0x16)	10	Reserved	

Table 19: Primary Flags Definitions

Bits	Size	Description	Comments
0	1	AllocationPossible	Must be 0
1	1	NoFatChain	Must be 0
2	14	CustomDefined	

TexFAT Padding Directory Entry

Offset	Size	Description	Comments
0 (0x00)	1	EntryType	0xA1
1 (0x01)	31	Reserved	

Remember:

exFAT 1.00 does not define TexFAT Padding directory entry. TexFAT Padding directory entries are only valid in the first cluster of directory and occupy every directory entry of the cluster. The implementations should not move TexFAT Padding directory entries.

Windows CE Access Control Table Directory Entry

Offset	Size	Description	Comments
0 (0x00)	1	EntryType	0xA2
1 (0x01)	31	Reserved	

Remember:

exFAT 1.00 does not define Windows CE Access Control Table Directory Entry.

Stream Extension Directory Entry

Offset	Size	Description	Comments
0 (0x00)	1	EntryType	0xC0

Offset	Size	Description	Comments
1 (0x01)	1	GeneralSecondaryFlags (see below)	
2 (0x02)	1	Reserved1	
3 (0x03)	1	NameLength	Length of Unicode name contained in subsequent File Name directory entries
4 (0x04)	2	NameHash	Hash of up-cased file name
6 (0x06)	2	Reserved2	
8 (0x08)	8	ValidDataLength	Must be between 0 and DataLength
16 (0x10)	4	Reserved3	
20 (0x14)	4	FirstCluster	
24 (0x18)	8	DataLength	For directories maximum 256 MB

Table 20: Secondary Flags Definitions

Bits	Size	Description	Comments
0	1	AllocationPossible	Must be 1
1	1	NoFatChain	
2	14	CustomDefined	

Stream Extension directory entry must immediately follow the File directory entry in the set. It could be only one Stream Extension entry in the set. If NoFatChain flag is set, all allocated clusters are contiguous.

The NameHash field facilitates the purpose of fast file name comparison and is performed on up-cased file name. NameHash verify against a mismatch, however matching hashes cannot guarantee the equality of file names. If name hashes match, a subsequent full name comparison must be performed.

```
// fileName points to up-cased file name
UINT16 NameHash(WCHAR *fileName, int nameLength)
{
  UINT16 hash = 0;
  unsigned char *data = (unsigned char *)fileName;

  for (int i = 0; i < nameLength * 2; i++)
    hash = (hash << 15) | (hash >> 1) + data[i];

  return hash;
}
```

ValidDataLength determines how much actual data written to the file. Implementation shall update this field as data has been written. The data beyond the valid data length is undefined and implementation shall return zeros.

File Name Directory Entry

Offset	Size	Description	Comments
0 (0x00)	1	EntryType	0xC1
1 (0x01)	1	GeneralSecondaryFlags (see below)	
2 (0x02)	30	FileName	

Table 21: Secondary Flags Definitions

Bits	Size	Description	Comments
0	1	AllocationPossible	Must be 0
1	1	NoFatChain	Must be 0
2	14	CustomDefined	

File Name directory entries must immediately follow the Steam Extension directory entry in the number of NameLength/15 rounded up. The maximum number of File Name entries is 17, each can hold up to 15 Unicode characters and the maximum file name length is 255. Unused portion of FileName field must be set to 0x0000.

Table 22: Invalid File Name Characters

Character Code	Character	Description
0x0000 – 0x001F		Control codes
0x0022	“	Quotation mark
0x002A	*	Asterisk
0x002F	/	Forward slash
0x003A	:	Colon
0x003C	<	Less than
0x003E	>	Greater than
0x003F	?	Question mark
0x005C	\	Back slash
0x007C	|	Vertical bar

exFAT Cluster Heap

Understanding of underlying mechanisms of data storage, organization and data recovery.

The cluster heap is a set of clusters which hold data in exFAT. It contains:

- Root Directory
- Files
- Directories
- *Allocation Bitmap* on page 182
- *Up-case Table* on page 182

The allocation status of clusters in cluster heap is tracked by Bitmap Allocation Table which itself located inside the cluster heap.

Allocation Bitmap

Allocation Bitmap keeps track of the allocation status of clusters. FAT does not serve this purpose as in FAT16/ FAT32 file system. Allocation Bitmap consists of a number of 8 bit bytes which can be treated as a sequence of bits. Each bit in bitmap corresponds to a data cluster. If it has a value of 1, the cluster is occupied, if 0 - the cluster is free. The least significant bit of bitmap table refers to the first cluster, i.e. cluster 2.

Offset	Size	Description	Comments
0x00	1	1st byte	Clusters 2-9
0x01	1	2nd byte	Clusters 10-17
0x02	1	3rd byte	Clusters 18-25
…			

Bitmap allocation table resides in cluster heap and referred by Bitmap Directory entry in root directory.

In TexFAT could be 2 Bitmap Allocation tables, otherwise there will be only one bitmap. The NumberOfFats field in Boot Sectors determines the number of valid Allocation Bitmap directory entries in the root directory and the number of Allocation Bitmaps.

Up-case Table

Up-case table contains data used for conversion from lower-case to upper-case characters. File Name Directory Entry uses Unicode characters and preserves case when storing file name. exFAT itself is case insensitive, so it needs to compare file names converted to the upper-case during search operations.

Normally Up-case table is located right after Bitmap Allocation table but can be placed anywhere is the cluster heap. It has a corresponding primary critical directory entry in the root directory.

Up-case Table is an array of Unicode characters, an index of which represents the Unicode characters to be up-cased and the value is the target up-cased character. The Up-case Table shall contain at least 128 mandatory Unicode mappings. If implementation supports only mandatory 128 characters it may ignore the rest of Up-case Table. When up-casing file names such implementation shall up-case only characters from the mandatory 128 characters set and leave other characters intact. When comparing file names which are different only by characters in non-mandatory set, those file names shall be treated as equal.

Index	Value	Comments
0x0000	0x0000	
0x0001	0x0001	
0x0002	0x0002	
…	…	..
0x0041	0x0041	‘A’ is mapped into itself (identity mapping)
0x0042	0x0042	‘B’ is mapped into itself
..	..	..
0x061	0x041	‘a’ is mapped into ‘A’ (non-identity mapping)
0x062	0x0042	‘b’ is mapped into ‘B’
..	..	..

Up-case Table can be written in compressed format where the series of identity mappings is represented with 0xFFFF followed by the number of identity mappings.

```
Mandatory First 128 Up-case Table Entries

Index |  Table Entries
_____________________________________________________________________________________________

0000  -  0000 0001 0002 0003 0004 0005 0006 0007 0008 0009 000A 000B 000C 000D
 000E 000F
0010  -  0010 0011 0012 0013 0014 0015 0016 0017 0018 0019 001A 001B 001C 001D
 001E 001F
0020  -  0020 0021 0022 0023 0024 0025 0026 0027 0028 0029 002A 002B 002C 002D
 002E 002F
0030  -  0030 0031 0032 0033 0034 0035 0036 0037 0038 0039 003A 003B 003C 003D
 003E 003F
0040  -  0040 0041 0042 0043 0044 0045 0046 0047 0048 0049 004A 004B 004C 004D
 004E 004F
0050  -  0050 0051 0052 0053 0054 0055 0056 0057 0058 0059 005A 005B 005C 005D
 005E 005F
0060  -  0060 0041 0042 0043 0044 0045 0046 0047 0048 0049 004A 004B 004C 004D
 004E 004F
0070  -  0050 0051 0052 0053 0054 0055 0056 0057 0058 0059 005A 007B 007C 007D
 007E 007F
```

Remember:

Non-identity mappings are highlighted in **bold**.

```
Mandatory First 128 Up-case Table Entries in compressed format

Index |  Table Entries
_____________________________________________________________________________________________

0000  -  FFFF 0061 0041 0042 0043 0044 0045 0046 0047 0048 0049 004A 004B 004C
 004D 004E
0010  -  004F 0050 0051 0052 0053 0054 0055 0056 0057 0058 0059 005A FFFF
 0005
```

The first highlighted group describes that first 0x0061 characters (0x0000-0x0060) have identity mappings. The next character after it (0x0061) maps to 0x0041 etc. until the next compressed group is encountered.

Remember:

The first highlighted **in bold** group describes that first 0x0061 characters (0x0000-0x0060) have identity mappings. The next character after it (0x0061) maps to 0x0041 etc. until the next compressed group is encountered.

Data Recovery Concept

Understanding of underlying mechanisms of data storage organization and data recovery.

Software recovery algorithms in nutshell:

Understanding File Recovery Process

Describes basic approaches and techniques of File and Folder recovery process.

Understanding Partition Recovery Process

Describes most common partition failures and techniques of their recovery.

File Recovery Process

Understanding of underlying mechanisms of data storage, organization and data recovery.

File recovery process can be briefly described as drive or folder scanning to find deleted entries in Root Folder (FAT) or Master File Table (NTFS) then for the particular deleted entry, defining clusters chain to be recovered and then copying contents of these clusters to the newly created file.

Different file systems maintain their own specific logical data structures, however basically each file system:

- Has a list or catalogue of file entries, so we can iterate through this list and entries, marked as deleted
- Keeps for each entry a list of data clusters, so we can try to find out set of clusters composing the file

After finding out the proper file entry and assembling set of clusters, composing the file, read and copy these clusters to another location.

Step by Step with examples:

- *Disk scan for deleted entries* on page 184
- *Define clusters chain for the deleted entry* on page 187
- *Clusters chain recovery for the deleted entry* on page 189

However, not every deleted file can be recovered, there are some assumptions, for sure:

- First, we assume that the file entry still exists (not overwritten with other data). The less the files have been created on the drive where the deleted file was resided, the more chances that space for the deleted file entry has not been used for other entries.
- Second, we assume that the file entry is more or less safe to point to the proper place where file clusters are located. In some cases (it has been noticed in Windows XP, on large FAT32 volumes) operating system damages file entries right after deletion so that the first data cluster becomes invalid and further entry restoration is not possible.
- Third, we assume that the file data clusters are safe (not overwritten with other data). The less the write operations have been performed on the drive where deleted file was resided, the more chances that the space occupied by data clusters of the deleted file has not been used for other data storage.

Important:

As general advices after data loss:

1. **DO NOT WRITE ANYTHING ONTO THE DRIVE CONTAINING YOUR IMPORTANT DATA THAT YOU HAVE JUST DELETED ACCIDENTALLY!** Even data recovery software installation could spoil your sensitive data. If the data is really important to you and you do not have another logical drive to install software to, take the whole hard drive out of the computer and plug it into another computer where data recovery software has been already installed or use recovery software that does not require installation, for example recovery software which is capable to run from bootable floppy.

2. **DO NOT TRY TO SAVE ONTO THE SAME DRIVE DATA THAT YOU FOUND AND TRYING TO RECOVER!** When saving recovered data onto the same drive where sensitive data is located, you can intrude in process of recovering by overwriting FAT/MFT records for this and other deleted entries. It's better to save data onto another logical, removable, network or floppy drive.

Disk scan for deleted entries

Understanding of underlying mechanisms of data storage, organization and data recovery.

Disk Scanning is a process of low-level enumeration of all entries in the *Root Folders* on FAT12, FAT16, FAT32 or in Master File Table (MFT) on NTFS, NTFS5. The goal is to find and display deleted entries.

In spite of different file/folder entry structure for the different file systems, all of them contain basic file attributes like name, size, creation and modification date/time, file attributes, existing/deleted status, etc...

Given that a drive contains root file table and any file table (MFT, root folder of the drive, regular folder, or even deleted folder) has location, size and predefined structure, we can scan it from the beginning to the end checking each entry, if it's deleted or not and then display information for all found deleted entries.

Note:

Deleted entries are marked differently depending on the file system. For example, in FAT any deleted entry, file or folder has been marked with ASCII symbol **229** (**OxE5**) that becomes first symbol of the *entry*. On NTFS deleted entry has a special attribute in file header that points whether the file has been deleted or not.

Example of scanning folder on FAT16

```
1. Existing folder MyFolder entry (long entry and short entry)

Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
-------------------------------------------------------------------------------
0003EE20   41 4D 00 79 00 46 00 6F  00 6C 00 0F 00 09 64 00   AM.y.F.o.l....d.
0003EE30   65 00 72 00 00 00 FF FF  FF FF 00 00 FF FF FF FF   e.r...yyyy..yyyy
0003EE40   4D 59 46 4F 4C 44 45 52  20 20 20 10 00 4A C4 93   MYFOLDER   ..JA"
0003EE50   56 2B 56 2B 00 00 C5 93  56 2B 02 00 00 00 00 00   V+V+..A"V+......

2. Deleted file MyFile.txt entry (long entry and short entry)
0003EE60   E5 4D 00 79 00 46 00 69  00 6C 00 0F 00 BA 65 00   aM.y.F.i.l...?e.
0003EE70   2E 00 74 00 78 00 74 00  00 00 00 00 FF FF FF FF   ..t.x.t.....yyyy
0003EE80   E5 59 46 49 4C 45 20 20  54 58 54 20 00 C3 D6 93   aYFILE  TXT .AO"
0003EE90   56 2B 56 2B 00 00 EE 93  56 2B 03 00 33 B7 01 00   V+V+..i"V+..3·..

4. Existing file Setuplog.txt entry (the only short entry)
0003EEA0   53 45 54 55 50 4C 4F 47  54 58 54 20 18 8C F7 93   SETUPLOGTXT
 .??"
0003EEB0   56 2B 56 2B 00 00 03 14  47 2B 07 00 8D 33 03 00   V+V+....G+..?3..
0003EEC0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
0003EED0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
```

This folder contains 3 entries, one of them is deleted. First entry is an existing folder **MyFolder**. Second one is a deleted file **MyFile.txt** Third one is an existing file **Setuplog.txt**.

First symbol of the deleted file entry is marked with **E5** symbol, so Disk Scanner can assume that this entry has been deleted.

Example of scanning folder on NTFS5 (Windows 2000):

For our drive we have input parameters:

- Total Sectors 610406
- Cluster size 512 bytes
- One Sector per Cluster
- MFT starts from offset 0x4000, non-fragmented
- MFT record size 1024 bytes
- MFT Size 1968 records

Thus we can iterate through all 1968 MFT records, starting from the absolute offset 0x4000 on the volume looking for the deleted entries. We are interested in MFT entry 57 having offset 0x4000 + 57 * 1024 = 74752 = 0x12400 because it contains our recently deleted file "My Presentation.ppt"

Below MFT record number 57 is displayed:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
-------------------------------------------------------------------------------
00012400   46 49 4C 45 2A 00 03 00  9C 74 21 03 00 00 00 00   FILE*...?
t!.....
00012410   47 00 02 00 30 00 00 00  D8 01 00 00 00 04 00 00   G...0...O.......
00012420   00 00 00 00 00 00 00 00  05 00 03 00 00 00 00 00   ................
00012430   10 00 00 00 60 00 00 00  00 00 00 00 00 00 00 00   ....`...........
00012440   48 00 00 00 18 00 00 00  20 53 DD A3 18 F1 C1 01   H....... SY?.nA.
00012450   00 30 2B D8 48 E9 C0 01  C0 BF 20 A0 18 F1 C1 01   .0+OHeA.A? .nA.
```

```
00012460   20 53 DD A3 18 F1 C1 01  20 00 00 00 00 00 00 00   SY?.nA. .......
00012470   00 00 00 00 00 00 00 00  00 00 00 00 02 01 00 00   ................
00012480   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
00012490   30 00 00 00 78 00 00 00  00 00 00 00 00 00 03 00   0...x...........
000124A0   5A 00 00 00 18 00 01 00  05 00 00 00 00 00 05 00   Z...............
000124B0   20 53 DD A3 18 F1 C1 01  20 53 DD A3 18 F1 C1 01   SY?.nA. SY?.nA.
000124C0   20 53 DD A3 18 F1 C1 01  20 53 DD A3 18 F1 C1 01   SY?.nA. SY?.nA.
000124D0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
000124E0   20 00 00 00 00 00 00 00  0C 02 4D 00 59 00 50 00   .........M.Y.P.
000124F0   52 00 45 00 53 00 7E 00  31 00 2E 00 50 00 50 00   R.E.S.~.1...P.P.
00012500   54 00 69 00 6F 00 6E 00  30 00 00 00 80 00 00 00   T.i.o.n.0...^...
00012510   00 00 00 00 00 00 02 00  68 00 00 00 18 00 01 00   ........h.......
00012520   05 00 00 00 00 00 05 00  20 53 DD A3 18 F1 C1 01   ........ SY?.nA.
00012530   20 53 DD A3 18 F1 C1 01  20 53 DD A3 18 F1 C1 01   SY?.nA. SY?.nA.
00012540   20 53 DD A3 18 F1 C1 01  00 00 00 00 00 00 00 00   SY?.nA.........
00012550   00 00 00 00 00 00 00 00  20 00 00 00 00 00 00 00   ........ .......
00012560   13 01 4D 00 79 00 20 00  50 00 72 00 65 00 73 00
  ..M.y. .P.r.e.s.
00012570   65 00 6E 00 74 00 61 00  74 00 69 00 6F 00 6E 00   e.n.t.a.t.i.o.n.
00012580   2E 00 70 00 70 00 74 00  80 00 00 00 48 00 00 00
 ..p.p.t.^...H...
00012590   01 00 00 00 00 00 04 00  00 00 00 00 00 00 00 00
  ................
000125A0   6D 00 00 00 00 00 00 00  40 00 00 00 00 00 00 00
 m.......@.......
000125B0   00 DC 00 00 00 00 00 00  00 DC 00 00 00 00 00 00
  .U.......U......
000125C0   00 DC 00 00 00 00 00 00  31 6E EB C4 04 00 00 00   .U......1neA....
000125D0   FF FF FF FF 82 79 47 11  00 00 00 00 00 00 00 00   yyyy,yG.........
000125E0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
000125F0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 03 00   ................
................
00012600   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
```

MFT Record has pre-defined structure. It has a set of attributes defining any file of folder parameters.

MFT Record begins with standard File Record Header (first bold section, offset 0x00):

- "FILE" identifier (4 bytes)
- Offset to update sequence (2 bytes)
- Size of update sequence (2 bytes)
- $LogFile Sequence Number (LSN) (8 bytes)
- Sequence Number (2 bytes)
- Reference Count (2 bytes)
- Offset to Update Sequence Array (2 bytes)
- Flags (2 bytes)
- Real size of the FILE record (4 bytes)
- Allocated size of the FILE record (4 bytes)
- File reference to the base FILE record (8 bytes)
- Next Attribute Id (2 bytes)

The most important information for us in this block is a file state: deleted or in-use. If Flags (in red color) field has bit 1 set, it means that file is in-use. In our example it is zero, i.e. file is deleted.

Starting from 0x48, we have **Standard Information** Attribute (second bold section):

- File Creation Time (8 bytes)
- File Last Modification Time (8 bytes)
- File Last Modification Time for File Record (8 bytes)
- File Access Time for File Record (8 bytes)

- DOS File Permissions (4 bytes) 0x20 in our case Archive Attribute

Following standard attribute header, we have **File Name** Attribute belonging to DOS name space, short file names, (third bold section, offset 0xA8) and again following standard attribute header, we have **File Name** Attribute belonging to Win32 name space, long file names, (third bold section, offset 0x120):

- File Reference to the Parent Directory (8 bytes)
- File Modification Times (32 bytes)
- Allocated Size of the File (8 bytes)
- Real Size of the File (8 bytes)
- Flags (8 bytes)
- Length of File Name (1 byte)
- File Name Space (1 byte)
- File Name (Length of File Name * 2 bytes)

In our case from this section we can extract file name, "My Presentation.ppt", File Creation and Modification times, and Parent Directory Record number.

Starting from offset 0x188, there is a non-resident Data attribute (green section).

- Attribute Type (4 bytes) (e.g. 0x80)
- Length including header (4 bytes)
- Non-resident flag (1 byte)
- Name length (1 byte)
- Offset to the Name (2 bytes)
- Flags (2 bytes)
- Attribute Id (2 bytes)
- Starting VCN (8 bytes)
- Last VCN (8 bytes)
- Offset to the Data Runs (2 bytes)
- Compression Unit Size (2 bytes)
- Padding (4 bytes)
- Allocated size of the attribute (8 bytes)
- Real size of the attribute (8 bytes)
- Initialized data size of the stream (8 bytes)
- Data Runs ...

In this section we are interested in Compression Unit size (zero in our case means non-compressed), Allocated and Real size of attribute that is equal to our file size (0xDC00 = 56320 bytes), and Data Runs (see the next topic).

Define clusters chain for the deleted entry

Understanding of underlying mechanisms of data storage, organization and data recovery.

To define clusters chain we need to scan drive, going through one by one all file (NTFS) clusters or free (FAT) clusters belonging (presumably) to the file until we reach the file size equals to the total size of the selected clusters. If the file is fragmented, clusters chain will be composed of several extents in case of NTFS or we take clusters bypassing occupied ones in case of FAT.

Location of these clusters can vary depending on file system. For example, file deleted on FAT volume has its first cluster in its Root entry, the other clusters can be found in File Allocation Table. On NTFS each file has _DATA_ attribute that describes "data runs". Disassembling data runs to "extents" for each extent we have start cluster offset and number of clusters in extent, so enumerating extents, we can compose file's cluster chain.

You can try to define clusters chain manually, using low-level disk editors, however it's much simpler to use data recovery tools, like Active@ UNDELETE.

Example of defining clusters chain on FAT16

Lets continue examine an example for deleted file **MyFile.txt** from the previous topic.

The folder, we scanned before contains a record for this file:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
-----------------------------------------------------------------------------
0003EE60   E5 4D 00 79 00 46 00 69  00 6C 00 0F 00 BA 65 00   aM.y.F.i.l...?e.
0003EE70   2E 00 74 00 78 00 74 00  00 00 00 00 FF FF FF FF   ..t.x.t.....yyyy
0003EE80   E5 59 46 49 4C 45 20 20  54 58 54 20 00 C3 D6 93   aYFILE  TXT .AO"
0003EE90   56 2B 56 2B 00 00 EE 93  56 2B 03 00 33 B7 01 00   V+V+..i"V+..3·..
```

We can calculate size of the deleted file based on root entry structure. Last four bytes are `33 B7 01 00` and converting them to decimal value (changing bytes order), we get `112435` bytes. Previous 2 bytes (`03 00`) are the number of the first cluster of the deleted file. Repeating for them the conversion operation, we get number `03` - this is the start cluster of the file.

What we can see in the File Allocation Table at this moment?

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
-----------------------------------------------------------------------------
00000200   F8 FF FF FF FF FF 00 00  00 00 00 00 00 00 08 00   oyyyyy..........
00000210   09 00 0A 00 0B 00 0C 00  0D 00 FF FF 00 00 00 00   ..........yy....
00000220   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ................
```

Zeros! And it is good in our case - it means that these clusters are free, i.e. most likely our file was not overwritten by other file's data. Now we have chain of clusters `3, 4, 5, 6` and ready to recover it.

Some explanations:

- we started looking from offset 6 because each cluster entry in FAT16 takes 2 bytes, our file starts from 3rd cluster, i.e. 3*2=6.
- we considered 4 clusters because cluster size on our drive is 32 Kb, our file size is 112, 435 bytes, i.e. 3clusters*32Kb = 96Kb plus a little bit more.
- we assumed that this file was not fragmented, i.e. all clusters were located consequently. We need 4 clusters, we found 4 free consecutive clusters, so this assumption sounds reasonable, although in real life it may be not true.

Note:

There are a lot of cases where the file's data can not be successfully recovered, because clusters chain can not be defined. Most of them occur when you write another data (files, folders) on the same drive where deleted file located. You'll see these warnings while recovering data using, for example Active@ UNDELETE.

Example of defining clusters chain on NTFS

When recovering on NTFS part of DATA attribute called Data Runs give us location about file clusters. In most cases DATA attribute is stored inside MFT record, so if we found MFT record for the deleted file, most likely we'll be able to determine cluster's chain.

In example below DATA attribute is marked with a green color. Data Runs inside, marked as Bold.

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
-----------------------------------------------------------------------------
00012580   2E 00 70 00 70 00 74 00  80 00 00 00 48 00 00 00   ..p.p.t.€...H...
00012590   01 00 00 00 00 00 04 00  00 00 00 00 00 00 00 00   ................
000125A0   6D 00 00 00 00 00 00 00  40 00 00 00 00 00 00 00   m.......@.......
000125B0   00 DC 00 00 00 00 00 00  00 DC 00 00 00 00 00 00   .U.......U......
000125C0   00 DC 00 00 00 00 00 00  31 6E EB C4 04 00 00 00   .U......1neA....
000125D0   FF FF FF FF 82 79 47 11  00 00 00 00 00 00 00 00   yyyy,yG.........
```

Data Runs need to be decrypted. First byte (0x31) shows how many bytes are allocated for the length of the run (0x1 in our case) and for the first cluster offset (0x3 in our case). Next, we take one byte (0x6E) that points to the length of the run. Next, we pick up 3 bytes pointing to the start cluster offset (0xEBC404). Changing bytes order we get first cluster of the file 312555 (equals 0x04C4EB). Starting from this cluster we need to pick up 110 clusters (equals 0x6E). Next byte (0x00) tells us that no more data runs exist. Our file is not fragmented, so we have the only one data run.

Lets check, isn't there enough information about the file data? Cluster size is 512 bytes. We have 110 clusters, 110*512 = 56320 bytes. Our file size was defined as 56320 bytes, so we have enough information now to recover the file clusters.

Important:

1. DO NOT WRITE ANYTHING ONTO THE DRIVE CONTAINING YOUR IMPORTANT DATA THAT YOU HAVE JUST DELETED ACCIDENTALLY!Even data recovery software installation could spoil your sensitive data. If the data is really important to you, and you do not have another logical drive to install software to, take whole hard drive out of the computer and plug into another computer where data recovery software has been already installed.

2. DO NOT TRY TO SAVE ONTO THE SAME DRIVE DATA THAT YOU FOUND AND TRYING TO RECOVER!While saving recovered data onto the same drive where sensitive data was located, you can intrude in process of recovering by overwriting FAT records for this and other deleted entries. It's better to save data onto another logical, removable, network or floppy drive.

Clusters chain recovery for the deleted entry

Understanding of underlying mechanisms of data storage, organization and data recovery.

After clusters chain is defined, automatically or manually, the only task left is to read and save contents of the defined clusters to another place verifying their contents.

We have a chain of clusters; we can calculate each cluster offset from the beginning of the drive, using standard formulas. After that we copy amount of data equals to the cluster size, starting from the calculated offset into the newly created file. For the last one we copy not all cluster, but reminder from the file size minus number of copied clusters multiplied by cluster size.

Formulas for calculating cluster offset could vary depending on file system.

To calculate, for example, offset of the cluster for FAT we need to know:

- Boot sector size
- Number of FAT supported copies
- Size of one copy of FAT
- Size of main root folder
- Number of sectors per cluster
- Number of bytes per sector

On the NTFS, we have linear space so we can calculate cluster offset simply as cluster number multiplied by cluster size.

Example of recovery clusters chain on FAT16

Lets continue examine an example for deleted file **MyFile.txt** from the previous topics.

By now we have chain of clusters `3, 4, 5, 6` ready for recovering. Our cluster consists of 64 sectors, sector size is 512 bytes, so cluster size is: 64*512 = 32,768 bytes = 32 Kb First data sector is 535 (we have 1 boot sector, plus 2 copies of FAT by 251 sectors each, plus root folder 32 sectors, total 534 occupied by system data sectors). Clusters 0 and 1 do not exist, so first data cluster is 2. Cluster number 3 is next to cluster 2, i.e. is located 64 sectors behind the first data sector (535). i.e. 535 + 64 = 599 sector, equal offset of 306,668 byte from the beginning of the drive (0x4AE00).

With a help of low-level disk editor on the disk we can see our data starting with offset 0x4AE00, or 3 cluster, or 599 sector:

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
-------------------------------------------------------------------------
0004AE00   47 55 49 20 6D 6F 64 65  20 53 65 74 75 70 20 68   GUI mode Setup h
0004AE10   61 73 20 73 74 61 72 74  65 64 2E 0D 0A 43 3A 5C   as started...C:\
0004AE20   57 49 4E 4E 54 5C 44 72  69 76 65 72 20 43 61 63   WINNT\Driver Cac
```

All we need to do is just copy 112,435 bytes starting from this place because clusters chain is consecutive. If it was not - we would need to re-calculate offset of each found cluster, and copy 3 times by 64*512 = 32768 bytes starting from each cluster offset, and then from the last cluster copy reminder: 14,131 bytes that is calculated as 112,435 bytes - (3 * 32768 bytes).

Example of recovery clusters chain on NTFS

In our example we just need to pick up 110 clusters starting from the cluster 312555.

Cluster size is 512 byte, so the offset of the first cluster would be **512 * 312555 = 160028160 = 0x0989D600**

```
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
-------------------------------------------------------------------------
0989D600   D0 CF 11 E0 A1 B1 1A E1  00 00 00 00 00 00 00 00   ÐÏ.à¡±.á........
0989D610   00 00 00 00 00 00 00 00  3E 00 03 00 FE FF 09 00   ........>...þÿ..
0989D620   06 00 00 00 00 00 00 00  00 00 00 00 01 00 00 00   ................
0989D630   69 00 00 00 00 00 00 00  00 10 00 00 6B 00 00 00   i...........k...
0989D640   01 00 00 00 FE FF FF FF  00 00 00 00 6A 00 00 00   ....þÿÿÿ....j...
0989D650   FF FF FF FF FF FF FF FF  FF FF FF FF FF FF FF FF   ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
```

Here is our data. What's left to do is just reading from this point 110 clusters (56320 bytes) and then copy them to another location. Data recovery is complete now.

Important:

DO NOT SAVE ONTO THE SAME DRIVE DATA THAT YOU FOUND AND TRYING TO RECOVER! process of recovering by overwriting FAT records for this and other deleted entries. It's better to save data onto another logical, removable, network or floppy drive.

Partition Recovery Process

Understanding of underlying mechanisms of data storage, organization and data recovery.

System Boot Process

In some cases, the first indication of a problem with hard drive data is a refusal of the machine to perform a bootstrap startup. For the machine to be able to start properly, the following conditions must apply:

- Master Boot Record (MBR) exists and is safe
- Partition Table exists and contains at least one active partition

If the above is in place, executable code in the MBR selects an active partition and passes control there, so it can start loading the standard files (COMMAND.COM, NTLDR, ...) depending on the file system type on that partition.

If these files are missing or corrupted it will be impossible for the OS to boot - if you have ever seen the famous "NTLDR is missing ..." error, you understand the situation.

When using Active@ UNDELETE, the recovery software accesses the damaged drive at a low level, bypassing the standard system boot process (this is the same as if you instructed the computer to boot from another hard drive). Once the computer is running in this recovery environment, it will help you to see all other files and directories on the drive and allow you to copy data to a safe place on another drive.

Partition Visibility

A more serious situation exists if your computer will start and cannot see a drive partition or physical drive (see Note below). For the partition or physical drive to be visible to the Operating System the following conditions must apply:

- Partition/Drive can be found via Partition Table
- Partition/Drive boot sector is safe

If the above conditions are true, the OS can read the partition or physical drive parameters and display the drive in the list of the available drives.

If the file system is damaged (Root, FAT area on FAT12/FAT16/FAT32, or system MFT records on NTFS) the drive's content might not be displayed and we might see errors like "MFT is corrupted", or "Drive is invalid" ... If this is the case it is less likely that you will be able to restore your data. Do not despair, as there may be some tricks or tips to display some of the residual entries that are still safe, allowing you to recover your data to another location.

Partition recovery describes two things:

Physical partition recovery

The goal is to identify the problem and write information to the proper place on the hard drive so that the partition becomes visible to the OS again. This can be done using manual Disk Editors along with proper guidelines or using recovery software, designed specifically for this purpose. *Active@ Partition Recovery* software implements this approach.

Virtual partition recovery

The goal is to determine the critical parameters of the deleted/damaged/overwritten partition and render it open to scanning in order to display its content. This approach can be applied in some cases when physical partition recovery is not possible (for example, partition boot sector is dead) and is commonly used by recovery software. This process is almost impossible to implement it manually. *Active@ UNDELETE*, *Active@ UNERASER* software both implement this approach.

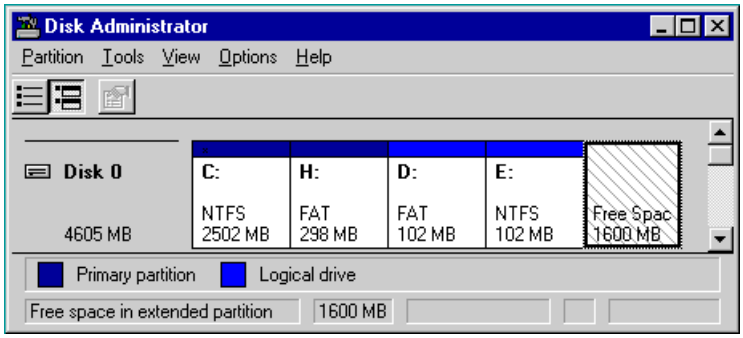
Note: If your computer has two operating systems and you choose to start in Windows 95/98 or ME, these operating systems cannot see partitions that are formatted for NTFS. This is normal operation for these operating systems. To view NTFS partitions, you must be in a Windows NT/2000/XP environment.

Other Partition Recovery Topics

These topics related to the recovery of partitions apply to any file system:

- *Damaged MBR* on page 191
- *Partition is deleted or Partition Table is damaged* on page 194
- *Partition Boot Sector is damaged* on page 196
- *Missing or Corrupted System Files* on page 198

For these topics the following disk layout will be used:



The figure shows a system with two primary partitions (C:(NTFS) and H:(FAT)) and one extended partition having two logical drives (D: (FAT) and E:(NTFS))

Damaged MBR

Understanding of underlying mechanisms of data storage, organization and data recovery.

The *Master Boot Record* (MBR) will be created when you create the first partition on the hard disk. It is very important data structure on the disk. The Master Boot Record contains the Partition Table for the disk and a small amount of executable code for the boot start. The location is always the first sector on the disk.

The first 446 (0x1BE) bytes are MBR itself, the next 64 bytes are the Partition Table, the last two bytes in the sector are a signature word for the sector and are always 0x55AA.

For our disk layout we have MBR:

```
Physical Sector: Cyl 0, Side 0, Sector 1
000000000   33 C0 8E D0 BC 00 7C FB  50 07 50 1F FC BE 1B 7C   3AZ??.|
uP.P.u?.|
000000010   BF 1B 06 50 57 B9 E5 01  F3 A4 CB BE BE 07 B1 04   ?..PW?a.o¤E??.
±.
000000020   38 2C 7C 09 75 15 83 C6  10 E2 F5 CD 18 8B 14 8B
 8,|.u.??.aoI.‹.‹
000000030   EE 83 C6 10 49 74 16 38  2C 74 F6 BE 10 07 4E AC
 i??.It.8,to?..N¬
000000040   3C 00 74 FA BB 07 00 B4  0E CD 10 EB F2 89 46 25   <.tu»..?.I.eo‰F
%
000000050   96 8A 46 04 B4 06 3C 0E  74 11 B4 0B 3C 0C 74 05   –
SF.?.<.t.?.<.t.
000000060   3A C4 75 2B 40 C6 46 25  06 75 24 BB AA 55 50 B4   :Au+@?F%.u$»?
UP?
000000070   41 CD 13 58 72 16 81 FB  55 AA 75 10 F6 C1 01 74   AI.Xr.?uU?
u.oA.t
000000080   0B 8A E0 88 56 24 C7 06  A1 06 EB 1E 88 66 04 BF   .Sa?V$C.?.e.?
f.?
000000090   0A 00 B8 01 02 8B DC 33  C9 83 FF 05 7F 03 8B 4E   ..?..‹U3E?y.□.‹N
0000000A0   25 03 4E 02 CD 13 72 29  BE 46 07 81 3E FE 7D 55   %.N.I.r)?F.?
>?}U
0000000B0   AA 74 5A 83 EF 05 7F DA  85 F6 75 83 BE 27 07 EB   ?tZ?ï.□U…ou??'.e
0000000C0   8A 98 91 52 99 03 46 08  13 56 0A E8 12 00 5A EB   S?'R™.F..V.e..Ze
0000000D0   D5 4F 74 E4 33 C0 CD 13  EB B8 00 00 00 00 00 00
 OOta3AI.e?......
0000000E0   56 33 F6 56 56 52 50 06  53 51 BE 10 00 56 8B F4
 V3oVVRP.SQ?..V‹o
0000000F0   50 52 B8 00 42 8A 56 24  CD 13 5A 58 8D 64 10 72   PR?.BSV$I.ZX?
d.r
000000100   0A 40 75 01 42 80 C7 02  E2 F7 F8 5E C3 EB 74 49   .@u.B€C.a?
o^AetI
000000110   6E 76 61 6C 69 64 20 70  61 72 74 69 74 69 6F 6E   nvalid
 partition
000000120   20 74 61 62 6C 65 00 45  72 72 6F 72 20 6C 6F 61    table.Error
 loa
000000130   64 69 6E 67 20 6F 70 65  72 61 74 69 6E 67 20 73   ding operating
 s
000000140   79 73 74 65 6D 00 4D 69  73 73 69 6E 67 20 6F 70   ystem.Missing
 op
000000150   65 72 61 74 69 6E 67 20  73 79 73 74 65 6D 00 00   erating
 system..
000000160   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000170   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000180   00 00 00 8B FC 1E 57 8B  F5 CB 00 00 00 00 00 00
  ...‹u.W‹oE......
000000190   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
0000001A0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
0000001B0   00 00 00 00 00 00 00 00  A6 34 1F BA 00 00 80 01   ........¦4.?..
€.
0000001C0   01 00 07 FE 7F 3E 3F 00  00 00 40 32 4E 00 00 00   ...?□>?...@2N...
```

```
0000001D0   41 3F 06 FE 7F 64 7F 32  4E 00 A6 50 09 00 00 00   A?.?□d□2N.¦P....
0000001E0   41 65 0F FE BF 4A 25 83  57 00 66 61 38 00 00 00   Ae.??J%?
W.fa8...
0000001F0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 55 AA
  ..............U?
```

What will happen if the first sector has been damaged (by virus, for example)?

Lets overwrite the first 16 bytes with zeros.

```
000000000   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000010   BF 1B 06 50 57 B9 E5 01  F3 A4 CB BE BE 07 B1 04   ?..PW?a.o¤E??.
±.
```

When we try to boot after hardware testing procedures, we see just blank screen without any messages. It means the piece of code at the beginning of the MBR could not be executed properly. That's why even error messages could not be displayed. However, if we boot from the floppy, we can see FAT partition, files on it and we are able to perform standard operations like file copy, program execution... It happens because in our example only part of the MBR has been damaged which does not allow the system to boot properly. However, the partition table is safe and we can access our drives when we boot from the operating system installed on the other drive.

What will happen if sector signature (last word 0x55AA) has been removed or damaged?

Lets write zeros to the location of sector signature.

```
Physical Sector: Cyl 0, Side 0, Sector 1
0000001E0   41 65 0F FE BF 4A 25 83  57 00 66 61 38 00 00 00   Ae.??J%?
W.fa8...
0000001F0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
 ................
```

When we try to boot now, we see an error message like "Operating System not found".

Thus the first thing if computer does not boot is to run Disk Viewer and check the first physical sector on HDD, whether it looks like valid MBR or not:

- check, may be it's filled up with zeros or any other single character
- check whether error messages (like you can see above "Invalid partition table"...) are present or not
- check whether disk signature (0x55AA) is present or not

The simplest way to repair or re-create MBR is to run Microsoft's standard utility called FDISK with a parameter / **MBR**, like

```
A:\> FDISK.EXE  /MBR
```

FDISK is a standard utility included in MS-DOS, Windows 95, 98, ME.

If you have Windows NT / 2000 / XP, you can boot from start-up floppy disks or CD-ROM, choose repair option during setup, and run **Recovery Console**. When you are logged on, you can run **FIXMBR** command to fix MBR.

Also you can use third party MBR recovery software or if you've created MBR backup, restore it from there (Active@ Partition Recovery has such capabilities).

What will happen if the first sector is bad/unreadable?

Most likely we'll get the same black screen, which we got when trying to boot. When you try to read it using Disk Viewer/Editor you should get an error message saying that sector is unreadable. In this case recovery software is unable to help you to bring HDD back to the working condition, i.e. physical partition recovery is not possible. The only thing that can be done is to scan and search for partitions (i.e. perform virtual partition recovery), and in case

if something is found - display them and give the user an opportunity to save important data to another location. Software, like Active@ UNDELETE, Active@ UNERASER will help you here.

Partition is deleted or Partition Table is damaged

Understanding of underlying mechanisms of data storage, organization and data recovery.

The information about primary partitions and extended partition is contained in the Partition Table, a 64-byte data structure, located in the same sector as the Master Boot Record (cylinder 0, head 0, sector 1). The Partition Table conforms to a standard layout, which is independent of the operating system. The last two bytes in the sector are a signature word for the sector and are always 0x55AA.

For our disk layout we have Partition Table:

```
Physical Sector: Cyl 0, Side 0, Sector 1
0000001B0                                                 80 01   ..............
€.
0000001C0   01 00 07 FE 7F 3E 3F 00  00 00 40 32 4E 00 00 00   ...?□>?...@2N....
0000001D0   41 3F 06 FE 7F 64 7F 32  4E 00 A6 50 09 00 00 00   A?.?□d□2N.¦P.....
0000001E0   41 65 0F FE BF 4A 25 83  57 00 66 61 38 00 00 00   Ae.??J%?
W.fa8...
0000001F0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 55 AA
  ..............U?
```

We can see three existing and one empty entries:

- Partition 1, offset 0x01BE (446)
- Partition 2, offset 0x01CE (462)
- Partition 3, offset 0x01DE (478)
- Partition 4 - empty, offset 0x01EE (494)

Each Partition Table entry is 16 bytes long, making a maximum of four entries available. Each partition entry has fields for Boot Indicator (BYTE), Starting Head (BYTE), Starting Sector (6 bits), Starting Cylinder (10 bits), System ID (BYTE), Ending Head (BYTE), Ending Sector (6 bits), Ending Cylinder (10 bits), Relative Sector (DWORD), Total Sectors (DWORD).

Thus the MBR loader can assume the location and size of partitions. MBR loader looks for the "active" partition, i.e. partition that has Boot Indicator equals 0x80 (the first one in our case) and passes control to the partition boot sector for further loading.

Lets consider the situations which cause computer to hang up while booting or data loss.

What will happen if no partition has been set to the Active state (Boot Indicator=0x80)?

Lets remove Boot Indicator from the first partition:

```
0000001B0                                                 00 01   ..............
0000001C0 01 00 07 FE 7F 3E 3F  00 00 00 40 32 4E 00 00 00   ...?□>?...@2N...
```

When we try to boot now, we see an error message like "Operating System not found". It means that the loader cannot determine which partition is system and active to pass control to.

What will happen if partition has been set to the Active state (Boot Indicator=0x80) but there are no system files on that partition?

(it could happen if we had used for example FDISK and selected not the proper active partition).

Loader will try to boot from there, fails, try to boot again from other devices like floppy, and if fails to boot again, we'll see an error message like "Non-System Disk or Disk Error".

What will happen if partition entry has been deleted?

If it has been deleted, next two partitions will move one line up in the partition table.

```
  Physical Sector: Cyl 0, Side 0, Sector 1

0000001B0                                                 80 00   ..............
€.
0000001C0   41 3F 06 FE 7F 64 7F 32  4E 00 A6 50 09 00 00 00   A?.?□d□2N.¦P.....
0000001D0   41 65 0F FE BF 4A 25 83  57 00 66 61 38 00 00 00   Ae.??J%?
W.fa8...
0000001E0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
0000001F0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 55 AA
  ..............U?
```

If we try to boot now, the previous second (FAT) partition becomes the first and the loader will try to boot from it. And if it's not a system partition, we'll get the same error messages.

What will happen if partition entry has been damaged?

Let's write zeros to the location of the first partition entry.

```
  Physical Sector: Cyl 0, Side 0, Sector 1

0000001B0                                                 80 00   ..............
€.
0000001C0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
0000001D0   41 3F 06 FE 7F 64 7F 32  4E 00 A6 50 09 00 00 00   A?.?□d□2N.¦P.....
0000001E0   41 65 0F FE BF 4A 25 83  57 00 66 61 38 00 00 00   Ae.??J%?
W.fa8...
0000001F0   00 00 00 00 00 00 00 00  00 00 00 00 00 00 55 AA
  ..............U?
```

If we try to boot now, the MBR loader will try to read and interpret zeros (or other garbage) as partition parameters and we'll get an error message like "Missing Operating System".

Thus, the second step in partition recovery is to run Disk Viewer and to make sure that the proper partition exists in the partition table and has been set as active.

How can recovery software help you in the above-mentioned scenarios?

1. Discover and suggest you to choose the partition to be active (even FDISK does so).
2. Discover and suggest you to choose the partition to be active.
3. Perform a free disk space scan to look for partition boot sector or remaining of the deleted partition information in order to try to reconstruct Partition Table entry for the deleted partition.
4. Perform all disk space scan to look for partition boot sector or remaining of the damaged partition information in order to try to reconstruct Partition Table entry for the damaged partition entry.

Why partition boot sector is so important?

Because if recovery software finds it, all necessary parameters to reconstruct partition entry in the Partition Table are there. (see *Partition Boot Sector is damaged* on page 196 topic for details).

What would happen if partition entry had been deleted then recreated with other parameters and re-formatted?

In this case, instead of the original partition entry we would have a new one and everything would work fine except that later on we could recall that we had some important data on the original partition. If you've created MBR, Partition Table, Volume Sectors backup (for example, Active@ Partition Recovery and Active@ UNERASER can do it) before, you can virtually restore it back and look for your data (in case if it has not been overwritten with new data yet). Some advanced recovery tools also have an ability to scan disk surface and try to reconstruct the previously

deleted partition information from the pieces of left information (i.e. perform virtual partition recovery). However it is not guaranteed that you can recover something.

Partition Boot Sector is damaged

Understanding of underlying mechanisms of data storage, organization and data recovery.

The Partition Boot Sector contains information, which the file system uses to access the volume. On personal computers, the Master Boot Record uses the Partition Boot Sector on the system partition to load the operating system kernel files. Partition Boot Sector is the first sector of the Partition.

For our first NTFS partition we have boot sector:

```
Physical Sector: Cyl 0, Side 1, Sector 1
Offset      0  1  2  3  4  5  6  7   8  9  A  B  C  D  E  F
000000000   EB 5B 90 4E 54 46 53 20  20 20 20 00 02 01 00 00   e[?NTFS
 .....
000000010   00 00 00 00 00 F8 00 00  3F 00 FF 00 3F 00 00 00
  .....o..?.y.?...
000000020   00 00 00 00 80 00 80 00  3F 32 4E 00 00 00 00 00   ....€.€.?
2N.....
000000030   5B 43 01 00 00 00 00 00  1F 19 27 00 00 00 00 00
 [C........'.....
000000040   02 00 00 00 08 00 00 00  10 EC 46 C4 00 47 C4 0C
  .........iFA.GA.
000000050   00 00 00 00 00 00 00 00  00 00 00 00 00 FA 33 C0
  ............u3A
000000060   8E D0 BC 00 7C FB B8 C0  07 8E D8 C7 06 54 00 00   Z??.|u?
A.ZOC.T..
000000070   00 C7 06 56 00 00 00 C7  06 5B 00 10 00 B8 00 0D   .C.V...C.
[...?..
000000080   8E C0 2B DB E8 07 00 68  00 0D 68 66 02 CB 50 53   ZA
+Ue..h..hf.EPS
000000090   51 52 06 66 A1 54 00 66  03 06 1C 00 66 33 D2 66   QR.f?
T.f....f3Of
0000000A0   0F B7 0E 18 00 66 F7 F1  FE C2 88 16 5A 00 66 8B   .·...f?n?
A?.Z.f‹
0000000B0   D0 66 C1 EA 10 F7 36 1A  00 88 16 25 00 A3 58 00   ?fAe.?6..?.%.?
X.
0000000C0   A1 18 00 2A 06 5A 00 40  3B 06 5B 00 76 03 A1 5B   ?..*.Z.@;.[.v.?
[
0000000D0   00 50 B4 02 8B 16 58 00  B1 06 D2 E6 0A 36 5A 00   .P?.‹.X.
±.O?.6Z.
0000000E0   8B CA 86 E9 8A 36 25 00  B2 80 CD 13 58 72 2A 01   ‹E†eS6%.?
€I.Xr*.
0000000F0   06 54 00 83 16 56 00 00  29 06 5B 00 76 0B C1 E0   .T.?.V..).
[.v.Aa
000000100   05 8C C2 03 D0 8E C2 EB  8A 07 5A 59 5B 58 C3 BE   .?A.?
ZAeS.ZY[XA?
000000110   59 01 EB 08 BE E3 01 EB  03 BE 39 01 E8 09 00 BE   Y.e.?a.e.?
9.e..?
000000120   AD 01 E8 03 00 FB EB FE  AC 3C 00 74 09 B4 0E BB   -.e..ue?
¬<.t.?.»
000000130   07 00 CD 10 EB F2 C3 1D  00 41 20 64 69 73 6B 20   ..I.eoA..A
 disk
000000140   72 65 61 64 20 65 72 72  6F 72 20 6F 63 63 75 72   read error
 occur
000000150   72 65 64 2E 0D 0A 00 29  00 41 20 6B 65 72 6E 65   red....).A
 kerne
000000160   6C 20 66 69 6C 65 20 69  73 20 6D 69 73 73 69 6E   l file is
 missin
000000170   67 20 66 72 6F 6D 20 74  68 65 20 64 69 73 6B 2E   g from the
 disk.
```

```
000000180   0D 0A 00 25 00 41 20 6B  65 72 6E 65 6C 20 66 69   ...%.A kernel
 fi
000000190   6C 65 20 69 73 20 74 6F  6F 20 64 69 73 63 6F 6E   le is too
 discon
0000001A0   74 69 67 75 6F 75 73 2E  0D 0A 00 33 00 49 6E 73
 tiguous....3.Ins
0000001B0   65 72 74 20 61 20 73 79  73 74 65 6D 20 64 69 73   ert a
 systemdis
0000001C0   6B 65 74 74 65 20 61 6E  64 20 72 65 73 74 61 72   kette and
 restar
0000001D0   74 0D 0A 74 68 65 20 73  79 73 74 65 6D 2E 0D 0A   t..the
 system...
0000001E0   00 17 00 5C 4E 54 4C 44  52 20 69 73 20 63 6F 6D   ...\NTLDR is
 com
0000001F0   70 72 65 73 73 65 64 2E  0D 0A 00 00 00 00 55 AA
 pressed.......U?
```

The printout is formatted in three sections:

- Bytes 0x00– 0x0A are the jump instruction and the OEM ID (shown in bold print).
- Bytes 0x0B–0x53 are the BIOS Parameter Block (BPB) and the extended BPB. This block contains such essential parameters as:
  - Bytes Per Sector (WORD, offset 0x0B),
  - Sectors Per Cluster (BYTE, offset 0x0D),
  - Media Descriptor (BYTE, offset 0x15),
  - Sectors Per Track (WORD, offset 0x18),
  - Number of Heads (WORD, offset 0x1A),
  - Hidden Sectors (DWORD, offset 0x1C),
  - Total Sectors (LONGLONG, offset 0x28), etc...
- The remaining code is the bootstrap code (that is necessary for the proper system boot) and the end of sector marker (shown in bold print).

This sector is so important on NTFS, for example, duplicate of the boot sector is located on the disk.

Boot Sector for FAT looks different, however its BPB contains parameters similar to the above mentioned. There is no extra copy of this sector stored anywhere, so recovery on FAT is as half as less successful than on NTFS.

What will happen if Partition Boot Sector is damaged or bad/unreadable?

Lets fill up with zeros several lines of Partition Boot Sector:

```
000000000   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000010   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000020   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000030   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000040   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000050   00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00
  ................
000000060   8E D0 BC 00 7C FB B8 C0  07 8E D8 C7 06 54 00 00   Z??.|u?
A.ZOC.T..
```

If we try to boot, we'll see "Non System Disk” or “Disk Error..". After we fail to load from it and from floppy, partition becomes not bootable.

Because a normally functioning system relies on the boot sector to access a volume, it is highly recommended that you run disk-scanning tools such as Chkdsk regularly, as well as back up all of your data files to protect against data loss in case you lose access to the volume.

Tools like Active@ Partition Recovery and Active@ UNERASER allow you to create backup of MBR, Partition Table and Volume Boot Sectors so that if for some reason it fails to boot, you can always restore your partition information and have an access to files/folders on that partition.

What to do if this sector is damaged?

- If we do have backup of the whole disk or MBR/Boot Sectors we can try to restore it from there.
- If we do not have backup, in case of NTFS we could try to locate a duplicate of Partition Boot Sector and get information from there.
- If duplicate boot sector is not found, only virtual partition recovery might be possible if we can determine critical partition parameters such as Sectors per Cluster, etc..

How can we fix NTFS boot sector using standard Windows NT/2000/XP tools?

On NTFS copy of boot sector is stored at the middle or at the end of the Volume.

You can boot from start-up floppy disks or CD-ROM, choose repair option during setup, and run **Recovery Console**. When you are logged on, you can run **FIXBOOT** command to try to fix boot sector.

How can recovery software help you in this situation?

- It can backup MBR, Partition Table and Boot Sectors and restore them in case of damage
- It can try to find out duplicate boot sector on the drive and re-create the original one or perform virtual data recovery based on found partition parameters
- Some advanced techniques allow assuming drive parameters even if duplicate boot sector is not found (i.e. perform virtual partition recovery) and give the user virtual access to the data on the drive to be able to copy them to the safer location.

Missing or Corrupted System Files

Understanding of underlying mechanisms of data storage, organization and data recovery.

For Operating System to boot properly, system files required to be safe.

In case of Windows 95 / 98 / ME, these files are *msdos.sys*, *config.sys, autoexec.bat, system.ini*, *system.dat*, *user.dat*, etc.

In case of Windows NT / 2000 / XP these files are: *NTLDR*, *ntdetect.com*, *boot.ini,*located at the root folder of the bootable volume, Registry files (i.e., *SAM*, *SECURITY*, *SYSTEM*and *SOFTWARE*), etc.

If these files have been deleted, corrupted, damaged by virus, Windows will be unable to boot. You'll see error messages like "NTLDR is missing ...".

So, the next step in recovery process is to check the existence and safety of system files (for sure, you won't able to check them all, but you must check at least *NTLDR*, *ntdetect.com*, *boot.ini* which cause most of problems).

To do it in Windows 95 / 98 / ME - you can boot in *Command Prompt* Mode, or from the bootable floppy and check system files in the command line or with a help of third party recovery software.

To do it in Windows NT / 2000 / XP, you can use Emergency Repair Process, Recovery Console or third party recovery software.

Emergency Repair Process

To proceed with Emergency Repair Process, you need Emergency Repair Disk (ERD). This disk is recommended to create after you install and customize Windows. To create it, use the "Backup" utility from System Tools. You can use the ERD to repair damaged boot sector, damaged MBR, repair or replace missing or damaged NT Loader (NTLDR) and ntdetect.com files.

If you do not have an ERD, the emergency repair process can attempt to locate your Windows installation and start repairing your system, but it may not be able to do so.

To run the process, boot from Windows bootable disks or CD, and choose Repair option when system suggests you to proceed with installation or repairing. Then press **R** to run Emergency Repair Process and choose Fast or Manual Repair option. Fast Repair is recommended for most users, Manual Repair - for Administrators and advanced users only.

If the emergency repair process is successful, your computer will automatically restart and you should have a working system

Recovery Console

Recovery Console is a command line utility similar to MS-DOS command line. You can list and display folder content, copy, delete, replace files, format drives and perform many other administrative tasks.

To run Recovery Console, boot from Windows bootable disks or CD and choose Repair option, when system suggests you to proceed with installation or repairing and then press **C** to run Recovery Console. You will be asked to which system you want to log on to and then for **Administrator'**s password, and after you logged on - you can display drive's contents, check the existence and safety of critical files and, for example, copy them back if they have been accidentally deleted.

Recovery Software

Third party recovery software in most cases does not allow you to deal with system files due to the risk of further damage to the system, however you can use it to check for the existence and safety of these files, or to perform virtual partition recovery.

Glossary

Dynamic Disk

A dynamic storage made out of whole or part of physical disk to increase performance and reliability

Extended Partition

A hard disk may contain only one extended partition; the extended partition can be subdivided into multiple logical partitions. In DOS/Windows systems, each logical partition may then be assigned an additional drive letter.

File Signature

Set of unique file properties, that allows

Virtual partition

A virtual copy of a volume (logical drive) using a defined geometry that emulates a real logical drive or partition

Virtual disk

A virtual copy of a physical disk using a defined disk geometry that uses real physical disk as a source but access it

Virtual RAID array

Software layer that sits above assembled physical disks that were part of a hardware RAID system.

boot record

See MBR.

boot partition

Name commonly used for the partition that contains the start-up files.

boot sector

Part of a hard disc, floppy disc, or similar data storage device that contains code for bootstrapping programs (usually, but not necessarily, operating systems) stored in other parts of the disc.

data storage device

See physical device.

disk geometry

Set of disk attributes that specify format, partitioning etc. of a disk

drive letter

Abstraction at the user level to distinguish one disk or partition from another. For example, the path C:\WINDOWS \represents a directory WINDOWS on the partition represented by C:.

FAT (File Allocation Table)

File that contains the records of every other file and directory in a FAT-formatted hard disk drive. The operating system needs this information to access the files. There are FAT32, FAT16 and FAT versions.

file system

Method in which files are named and where they are placed logically for storage and retrieval in a computer. Under scope of this document, one of the Microsoft Windows file systems, such as FAT12, FAT16, FAT32 and NTFS.

logical drive

Partitioned space on a physical device.

partition (disk)

Hard disk's storage space divided into independent parts.

physical device

Device for storing data, that can be connected internally (Hard Drive) or externally (USB Flash card, USB Hard Drive).

physical device geometry

see Disk Geometry

MBR (Master Boot Record)

All disks start with a boot sector. When you start the computer, the code in the MBR executes before the operating system is started. The location of the MBR is always track (cylinder) 0, side (head) 0, and sector 1. The MBR contains a file system identifier.

MFT or MFT records (Master File Table)

File that contains the records of every other file and directory in an NTFS-formatted hard disk drive. The operating system needs this information to access the files.

system partition

Name commonly used for the partition that contains the operating system files.

Virtual RAID Virtual Disk Array

Software layer that sits above assembled physical disks that were part of a hardware RAID system.

volume boot record

First sector of a data storage device that has not been partitioned, or the first sector of an individual partition on a data storage device that has been partitioned. It contains code to load and invoke the operating system (or other standalone program) installed on that device or within that partition.

Uninstall Active@ UNDELETE

How to uninstall Active@ UNDELETE.

Active@ UNDELETE software package comes with a standard installer\uninstaller accessible from the **Control Panel**.

To uninstall the software:

1. Open **Control Panel**;
2. Navigate **Programs & Features** > **Uninstall** or change a program;
3. Select Active@ UNDELETE section and click **Uninstall** or just double click it;
4. Click **Yes** to confirm uninstall process;